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The New Hawthorne Ave. Bridge at Portland, Ore.

By W. P. HARDESTY, C. E.*

At Portland, Ore., there has just been completed a bridge with some unusual features. It connects the east and west sides of the city across the Willamette River, at Hawthorne Ave., replacing an old bridge.

The bridge contains six steel spans, of which three are 209 ft. long and three 245 ft. long, c. to c. pins. One of the 245-ft. spans is a draw of the direct-lift type. The piers and abutments are of concrete on pile foundations; scour was forestalled by dredging to a safe depth before driving the piles. The steel structure is flanked by wood trestle approaches on either bank, these trestles aggregating 775 ft. in length.

The spans are through spans, with riveted Pratt trusses having curved top chords. The truss spacing is 23 ft. 3 ins. on centers, but the deck is nearly three times as wide (64 ft.), the floorbeams overhanging 19 ft. on either side. The driveway occupies the space between trusses, 20 ft. in the clear; immediately outside either truss is a street-car track occupying a width of 11 ft., and beyond this a 7-ft. sidewalk, separated from the track space by an iron railing. The unusually long overhang of the floorbeams necessitated very rigid connections and otherwise substantial design; the floorbeams are 60 ins. deep.

The lift-span is the most interesting feature of the bridge. It is the heaviest span of this rare type built up to the present. As stated, it is 245 ft. long; it is substantially the same as the adjacent 245-ft. span, with the addition of vertical hanger posts at the ends. Its total weight, including flooring and machinery (carried on the span) is about 885 tons.

The height of lift is 110 ft. This provides a clearance of 160 ft. during mean low water and 135 ft. at high water. The towers are 170 ft. high above their piers. They are of simple four-leg construction, with vertical front legs and inclined back legs, suitably braced together. The inside of the tower is utilized as a well for the counterweight. Each tower weighs about 128 tons.

The lifting arrangement consists essentially of the operating motors, their cable connections to the ends of the span and thence to the towers, the counterweight sheaves and the cables leading over them to the counterweights.

The operating mechanism is in a house on top of the span at its center. Here are two 125-HP. electric motors (each of sufficient capacity to handle the span) on the same shaft, which drives through toothed gearing two drum-shafts, one for each end of the span. At each end of either drum-shaft is a drum of about 3½ ft. diameter, on which is wound the hoisting cable. The two ends of the cable lead to the end of the span; here one passes under a sheave attached to the span and thence up to a connection with the top of the tower, serving for raising; the other end of the cable passes over another sheave attached to the span and thence down to a connection near the bottom of the tower, serving for lowering. These connections are provided with turnbuckles for adjusting the tension on the cable.

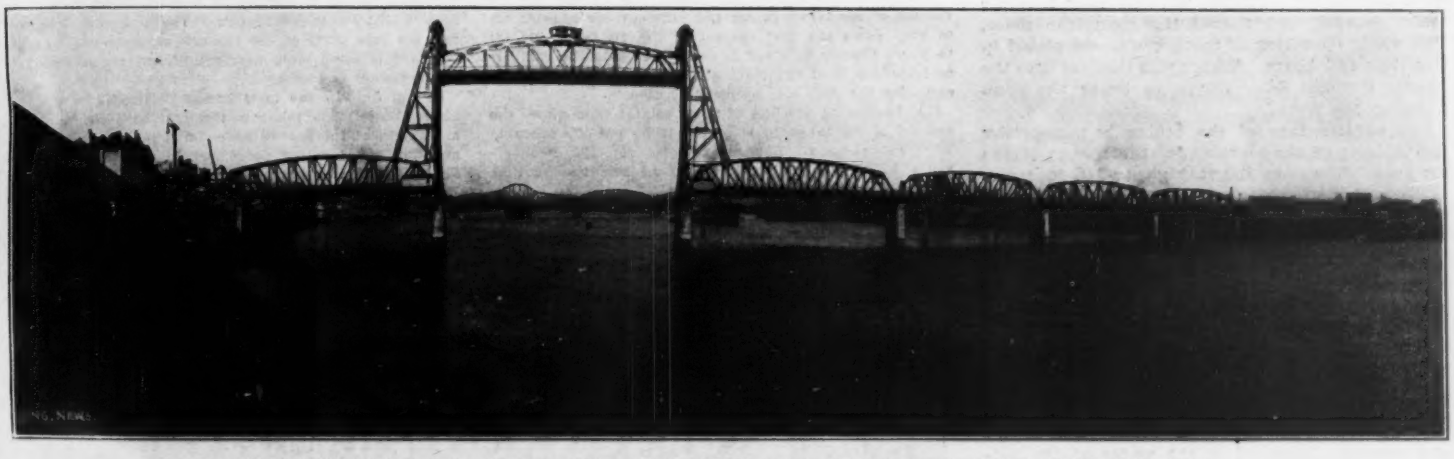
The main shaft has hand brakes applied through hand levers by the operator, and there is also an automatic brake for each motor. There is provided an automatic cut-off switch for the motors, adjusted to act as the span reaches either end of its trip. A graduated dial of some 6 ft. diameter, in front of the operator, indicates the position of the span at all times. Hand operating gear is also provided, with bevel-gear connection to the motor shaft.

The counterweights, one in each tower, are of concrete cast around a steel frame. Each is 21 ft. wide, 37 ft. 3 ins. high and 6 ft. 10 ins. thick, a volume of about 200 cu. yds., is made of 1:2:5 concrete, and is designed to weigh 442 tons, so as to counterbalance the span exactly. However, 21 auxiliary balance pieces of 1,500 lbs. each, also of concrete, are provided for getting close adjustment by placing them either on the span or on the main counterweight. At the corners of the counterweights are steel grooved guide-shoes, which run on Z-bar guides attached to the tower columns.

A hanger post at the end of each truss carries at its top an equalizer, which has a set of lever-arms for distributing the load to twelve counterweight cables. These cables, 1½-in. plow steel rope, are in two sets of six each, and pass up to the top of the tower and there over a 9-ft. sheave and down to the counterweight. With 12 cables at each end of each truss there are thus 48 cables, and 8 sheaves. Each end of each hanger post has a lateral guide roller running on the outer face of the adjacent tower column, and a face guide roller bearing on the forward face of the column. The face rollers are cushioned by springs, and these absorb all shocks due to longitudinal forces.

The full lift of 110 ft. ordinarily takes about ¾ to 1 min., with power operation, and under favorable conditions consumes only 20 HP. At ordinary water a lift of 20 ft. will clear the majority of the river boats, and the time required is correspondingly less. The average time from opening to closing has been found to be 2 mins., as against 6 mins. for the nearby Morrison Street swing-span, a bridge of good design and in good operating condition.*

The lift-span was built on falsework on the downstream side of the bridge just east of the draw, and it was floated into place. There were



GENERAL VIEW OF NEW HAWTHORNE AVE. BRIDGE OVER WILLAMETTE RIVER, PORTLAND, ORE.

*60 East 31st St. N., Portland, Ore.

*Information by the designing engineers.

used three scows, each carrying an elaborate tower bent of 12 × 12-in. timbers. The scows were run abreast under the span, after water had been let into them to lower them to the proper level. The water was then pumped out so that the timber bents lifted the span. The three scows were strongly braced and tied together so as to act practically as one. Two steamboats, headed upstream between the scows, then backed downstream, working over into the main channel, and floated the span into place. The whole operation of moving was completed in less than two hours. Water was then let into the barges through 6-in. valves to lower the span down on the piers.

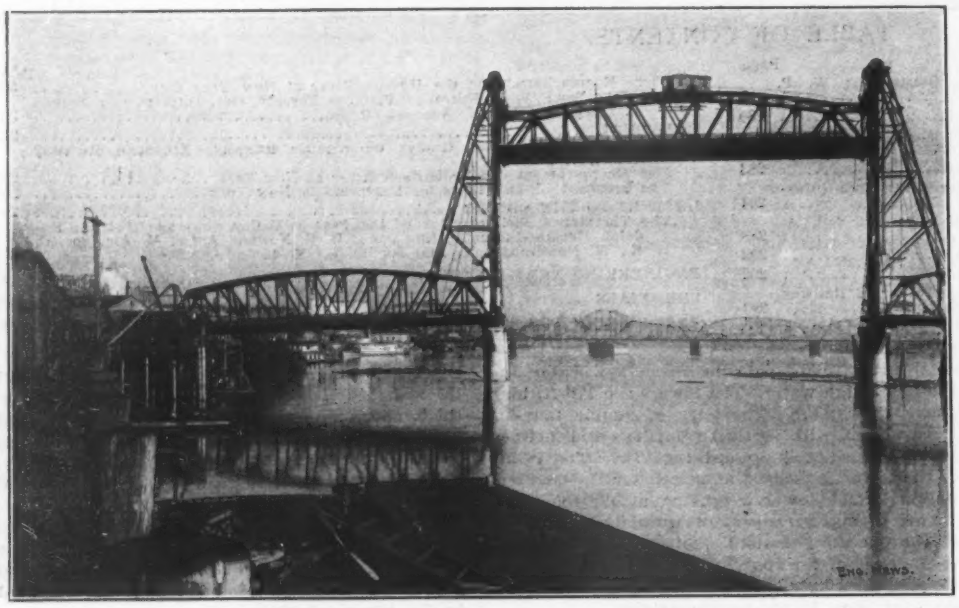


FIG. 1. LIFT SPAN AND WEST SHORE SPAN OF HAWTHORNE AVE. BRIDGE, PORTLAND, ORE.
(Lift span elevated. The concrete counterweights at both ends can be seen.)

The substructure of the bridge is noteworthy for the size of the piers under the towers of the lift span. They are 100 ft. high, or 145 ft. measured from bottoms of piles. They are of concrete deposited in cofferdams over pile foundations. Low-water depth at the pier location is about 35 ft., but the river was considerably above low-water stage when the piers were built. Each pier has a timber crib cofferdam 50 ft. high, which was sunk into the river bed 15 ft. Piles were sunk by water jet to a depth averaging 45 ft. below the crib, or 60 ft. below river bottom. It was possible to secure very long piles, 110 to 120 ft. long, which avoided the use of a follower. The crib was partly pumped out and concrete deposited in the water at the bottom sufficient to seal, when it was pumped out dry, the piles cut off, and the pier concrete placed in air.

The contract cost of the substructure of the bridge was $100,000, and of the superstructure $350,000.

The bridge was designed and built under the supervision of Waddell & Harrington, Consulting Engineers, Kansas City, Mo., engaged by the city of Portland. The lift span features are patented by that firm. The substructure was built by Robert Wakefield of Portland, the steel was fabricated by the Pennsylvania Steel Co., and the superstructure was built by the United Engineering & Construction Co., of Portland, Mr. A. S. Eldredge, Vice-President and General Manager.

MORE AUTOMATIC STOPS are to be installed in the New York rapid-transit subway. The express tracks have from the first been fully equipped with automatic signals and have had an automatic train-stop trip at every home signal. The local-train tracks, however, had signals at critical points only, and no automatic stops. The question was raised recently before the Public Service Commission whether these signals should not be increased so as to protect every part of the local-train tracks. After a hearing the Commission decided against this, but ordered that automatic stops be fitted at all existing signals on the local tracks. The number of points which will thus be protected is about one hundred.

The Ventilation of Railway Cars.*

By W. A. EVANS, M. D.†

A railroad car (passenger, Pullman, baggage, express, or postal) hurling through the air at the rate of 50 mi. an hr. has an air pressure of 10 lbs. per sq. ft. This furnishes more power than any blower fan in use. If a ventilating duct has its open face exposed to this current of air a volume will drive in many times the need of the inhabitants of the car.

The requirements, then, are these: (1) To regulate the volume of air taken in for the different car speeds; (2) to keep down the dust content of the air taken in; (3) to warm the air before it is introduced into the car; (4) to introduce it at the right place; (5) to provide proper exits for the foul air, properly located.

(1) Discussing the first of these points: Sometimes the amount of air taken in is regulated by cut-offs operated by the brakeman. Such is the case on the Pennsylvania Railroad. Here the brakeman sets the ventilation soon after the car leaves the station. A better system is that in use on the Northwestern Elevated, in Chicago. They use a small cut-off device in their in... When the car is standing still the blade hangs verti... and the duct is fully open. As the car speeds up, ... blade rises toward the horizontal and diminishes the ... of the duct proportionately. There is never any ques... as to getting air enough when the car is under w... The provision must be to keep the quantity down.

(2) In a railroad train the dust is from two sour... The smoke tends to hang along the top of the c... Ducts at this level are liable to catch a good ma... cinders and much smoke. The pounding of the ca... raises a good deal of track dust. The Pennsylva... Railroad takes in its air above the roof of the car a... uses screens to keep out cinders. Such an opening h... the additional advantage of being out of the way. ... disadvantage is the amount of friction from the leng... of the ducts. In the case of elevated trains the du... are advantageously located in the floor of the car a... take air in from below the floor line. The question o... the location of the ducts in surface street cars is some... what more difficult. The short ducts, when the inlets are below the floor level, present great advantages. The only disadvantage is the dust. The swirl of dust raised by a street car can be seen to hang a little in the rear of the car, except when it is stopping. The dust at the floor line of the car is far less than superficial observation would indicate. Openings through the floor can be provided with cheesecloth dust arresters when this is found necessary.

(3) The keynote of car ventilation is warming the air as it is taken in. A street car jammed with passengers will have only 10 cu. ft. of air per passenger. If, then, 2,000 cu. ft. of air per passenger per hour is furnished the air must be changed 200 times per hour, or, say, three times per minute. No passenger will allow such a volume of air on a cold day without the air having been previously warmed. Even if these figures are markedly diminished, the passengers will not tolerate the air if it is cold. On the other hand, the radiation in the car is usually placed under the seats or in out-of-the-way corners of the car. The result of this is that the seats are usually scorching hot and the remainder of the car is uncomfortably cold. The efficiency of the radiation is at a minimum because there is no provision for heat distribution. The proper solution is to introduce the fresh air into the car through the radiation. In this way the air is warmed to a point where the passengers will tolerate ventilation. The radiation is cooled and the cold parts of the car are warmed; the car temperature is made more nearly uniform; the efficiency of the radiation is increased.

(4 and 5). In the installations commonly in use, the air is theoretically taken in through the deck sash. The most efficient intakes we have found in such installations are the leaks around doors, windows, and joints. We think that the air entering through such openings when the car is crowded, when it is moving rapidly and when the outside temperature is around 10° F. above zero, will amount to 10,000 cu. ft. per hr. Deck sashes we have found to be very unsatisfactory for ventilation purposes, either as inlets or outlets. They will sometimes act as inlets, sometimes as outlets, and sometimes as neither, according to the direction and force of the wind, and according as the car is gaining speed, speeding, or losing speed. The great volume of air which comes in

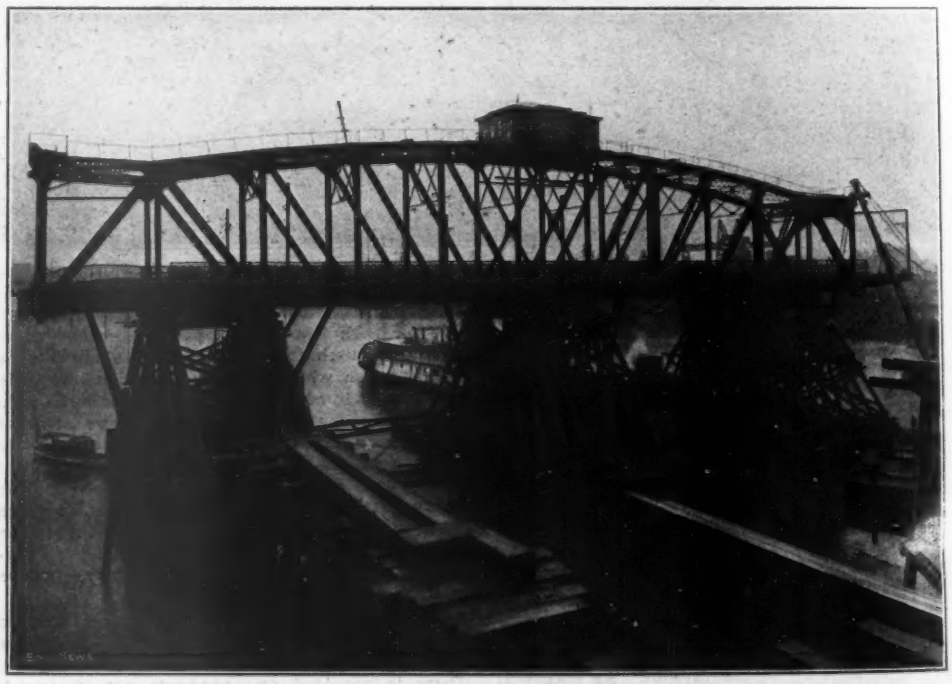


FIG. 2. FLOATING THE LIFT SPAN OF THE HAWTHORNE AVE. BRIDGE INTO PLACE.
(Steamers starting to back downstream after the span

*Portions of an article in the New York "Medical Record" for Dec. 3, 1910. [Following our extracts from this article will be found some remarks on Car Ventilation, taken from the latest published report of the Board of Supervising Engineers, Chicago Traction—Ed.]

†Commissioner of Health, Chicago, Ill.; Professor of Sanitary Science, Northwestern University Medical School.

through those sash openings which are acting as inlets will flow straight across and out of other sash openings acting as outlets. The best results in deck sash ventilation are had by opening the sashes forward on the windward side of the car for inlets and opening the rear sashes of the lee side of the car backward to serve as outlets. The theory of the use of deck sashes for inlets is that the cold air will mingle with the warm air and will therefore be somewhat warmed before it strikes the passengers. But no dilution system is ever safe with less than 1,800 cu. ft. of fresh air per passenger per hour, and in the case of crowded passengers from miscellaneous sources 3,000 to 5,000 cu. ft. is a necessity.

Now, cold air must be heated by something. The heating agencies in a car are the passengers and the radiation. Putting the air in at the deck sash and having the heat of the car heat it before it reaches the passengers may add to the passengers comfort. It does not save any in the expense of heating. If the fresh air is warmed enough to keep it from being uncomfortable and is then discharged into the car below the seat level and the foul air is taken out through ducts around ceiling lights, a somewhat uniform upward flow of air is maintained in the car. The partial separation of the fresh from the foul air makes it possible to reduce the volume of air required for each passenger. With such an arrangement of inlets and outlets, the Chicago Department of Health thinks it safe to reduce the air requirements to 400 cu. ft. per passenger per hour, and has had ordinances drawn along these lines.

Satisfactory results cannot be had with so low a quantity of air per passenger if cross currents and consequent dilution are to be brought about by open deck sashes. As car builders usually build deck sashes in cars, they should be closed in cold weather or only used in such a way that they will be outlets, i. e., by only opening those which are on the rear end of the car and on its lee side. A distinct gain in car ventilation will be made when cars are no longer built with deck sashes.

The most valuable contribution to the subject of car ventilation is to be found in the Master Car Builders' report for 1908. There are but two points which in my judgment should be changed or supplemented. The first suggestion is a change; the second a supplement.

The statement is made that suburban cars do not need any planned ventilation. This is because of the frequent stops and frequent opening of doors. We have made many observations and CO_2 determinations to ascertain the accuracy of this conclusion. It is not correct. It probably was with old-style, open-platform cars, with doors opening directly forward; with vestibule platforms and side doors it is not true. Suburban cars and street cars with more than two inmates between stops need planned ventilation.

The second point relates to passenger coaches and sleepers standing in stations or moving slowly in narrow rights of way in cities. The proper ventilation of day coaches and sleepers makes use of the force of the car through the air to drive fresh air into the car and foul air out of the car.

But a car at rest is deprived of this force. Therefore, force should be otherwise supplied, else the car quickly gets hot, humid, close, and its CO_2 content rises. Such cars should be provided with fans in the inlet ducts; these fans so adjusted that they will start as the car stops and stop when it starts.

A most important question is: Does a surface street car need fans to get fresh air into the car or to take foul air out of the car? I am sure that fans would give a more even supply of air and will be found more satisfactory, but I am not prepared to say that there can be no satisfactory street car ventilation without them.

To summarize:

(1) Bad car air is very prone to cause infections with (a) colds; (b) influenza; (c) pneumonia; (d) consumption; (e) possibly diphtheria, scarlet fever, and cerebro-spinal meningitis.

(2) Postal clerks, railroad men and street car men, and other habitual riders are prone to the bad air intoxications; (a) headaches; (b) sluggishness; (c) flabbiness; (d) sleepiness; (e) anemia; (f) proneness to infections.

(3) Jammed, crowded cars are most dangerous.

(4) Ventilation should always be through air entering low down, passing over or through radiators and flowing into the car below the seat line, and foul air leaving through the ceiling by ducts arranged around the lights.

(5) The air should enter the car at 50° or above.

(6) Street cars when heated should not have the temperature pass 55° F.

(7) In sleeping and passenger cars the temperature should not pass 65° F.

(8) Deck sash ventilation is never satisfactory.

(9) The air inlets should be so placed and so screened as to minimize the entrance of cinders and road dust.

(10) The inlet ducts should be as short and with as few angles as possible.

(11) In sleeping cars and day coaches there should be fans in the inlet ducts. These should run only when the car is standing.

(12) Greater uniformity is had in street car ventilation when fans are used to move the air.

The work upon which these conclusions are based has been done by men in the Chicago Department of Health, and under the direction of Dr. F. O. Tonney, Director of the Municipal Laboratories.

[An article on recent developments in car ventilation will be found in Eng. News for Dec. 23, 1909, p. 691. We append some remarks on Car Ventilation at Chicago, taken from the Second Annual Report of the Board of Supervising Engineers, Chicago Traction, for the year 1908-9.—Ed.]

Car Ventilation Studies, Board of Supervising Engineers, Chicago Traction.

During the year the subject of the ventilation of cars has been given considerable study and attention. Under the supervision of the city department of health tests have been made of a number of ventilating devices.

In cars of the double end, double entrance type, provided with large doors at each end of the car body through which passengers enter or leave, the opening of these doors at stops provides a certain amount of ventilation. In the new Chicago type of P-A-Y-E cars, however, the question of ventilation is more serious, as these cars are entered from one end only and there is little chance for draft through them when stops are made. The use of storm sash in the winter and the arrangement of the doors make these new P-A-Y-E cars comparatively "draft proof," and it becomes necessary to provide for a supply of fresh air.

It has been the practice for years past to provide ventilation by means of deck sash through which air could enter the car at the ceiling line and diffuse throughout the interior. On the Chicago P-A-Y-E cars additional apparatus in the form of large openings in the end transoms was provided. It was found that these end ventilators could supply a large amount of air, as the speed of the car forced air directly through them, but that when large amounts of air passed through them it resulted in a strong draft on the passengers.

The Commissioner of Health has stated that the principle of having the fresh air enter the car at the ceiling by means of deck sash, forcing the foul air down to the breathing zone, is improper from the health standpoint, and that the ventilation of a street car should be accomplished along the following lines:

(1) The fresh air should be taken into the car below the seat level, and passed over heaters; (2) the fresh air should enter the car at multiple points; (3) the foul air should be taken out at the ceiling.

It has also been stated by the Commissioner of Health that not less than 28,000 cu. ft. of fresh air per hour should be taken in through the intakes (located below the seat level) and passed over the car heating apparatus before entering the breathing zone of the car-body. It is estimated that the above amount of fresh air entering through the intakes, together with the amount which will leak in through opened doors and around the cracks of the doors, windows, etc., will make the total amount of air per hour admitted to the body of the car approximately 38,000 cu. ft., which will provide for an air change about once every one and one-half minutes. The above figures are based on a cubic capacity of car-body of approximately 1,000 cu. ft.

Experience with the new P-A-Y-E cars in Chicago, in which smoking is allowed on the front platform, has also shown the necessity of providing some means to take the smoke out of the front vestibule. This has been made one of the requirements of a ventilating system for Chicago P-A-Y-E cars.

In looking around for ventilating systems which would comply with the above requirements, it was found that none had been developed which would fulfill all of the conditions, as most of the devices provided for an exhaust of air from car at the ceiling, but depended on leakage through doors, etc., for supply of fresh air. Therefore, the makers of the various ventilating devices performed a considerable amount of pioneer work in developing the principle of intakes in the floor line, arranged so that the air must pass over the car heating equipment before entering the breathing zone of the car, and then be taken out at the ceiling. Among the automatic systems of ventilation developed to operate as outlined above and which were tested, are the Taylor, Acme and Garland.

These automatic systems depend on the speed of the car and in a measure upon the velocity and direction of the wind. They all work on the "Aspirator" principle, the rush of air past an opening creating a suction which draws the air out of the chamber to which the opening is connected.

It is evident from the principle on which the automatic systems depend for operation that there are certain conditions under which the automatic systems are practically inoperative. These conditions are as follows:

(a) Car standing still; no wind. Under this condition the only action of the ventilators would be that due to difference in temperature between outside and inside of car.

(b) Velocity and direction of wind the same as that of the car. Under this condition there would be no difference in velocity between the car and the air through which it is passing. Therefore, there would be no action of the exhaust ventilators except that induced by difference in temperature between outside air and that in the car.

The Taylor Automatic System consists of ejectors attached to the car at the deck sash openings and on vestibule hoods, and intakes in the floor by means of which the air is drawn over the heaters before passing into the breathing zone. The intakes are arranged with ducts projecting below the car floor and passing toward the outside of the car. The ends of the intake ducts are provided with a pivoted scoop so devised that it always faces toward the direction in which the car is moving. Ten deck-window openings, five on each side, are provided with two vertical vanes, one on each side of the opening, the vanes being hinged at their attachment to the window framing and arranged to swing very easily. These vanes assume a trailing position, due to the jerk of the car when it starts, and the air striking the inclined faces of these vanes is deflected, creating a suction between each pair of vanes. The opening between vanes into the car is provided with a regulating box having shutters, so constructed as to keep out the weather. The suction created between each pair of inclined vanes draws air out of the car through the regulating box. Each vestibule is also provided with two ejectors. The vestibule ejectors, however, are arranged with fixed curved vanes, so designed as to be operative when the car is moving either ahead or back.

It is clear from the description of the ejectors and intakes of the Taylor Automatic System that it has a considerable number of moving parts.

The Acme Automatic System consists of metal boxes, approximately rectangular in shape with open ends. The interior of the boxes are fitted with suitable vanes so arranged that the rush of air through the box or by the open ends of the box creates a suction which draws the air from the car interior through openings provided in the box and connected to the deck window openings of the car. For the ventilation of the car body four exhaust ventilators of the above type are used, one at each end transom and one on each side of the deck at the deck window openings. One exhaust ventilator of same design except of smaller dimensions, is placed on the roof of each vestibule. Intakes are placed in the floor and so designed as to convey the air over the heaters before it passes into the car. These intakes are arranged with ducts projecting below the floor and facing outward toward the sides of the car. The ends of the intakes are provided with fixed curved vanes, so designed that the speed of the car will tend to force the air up the intake into the car, when running either ahead or back.

The Garland Automatic System is familiar to many from its application to Pullman sleepers. It consists of "T" shaped boxes arranged to fit the contour of the roof and connected to the deck window openings. These boxes are open at all ends and the interior is fitted with suitable curved and straight vanes. The vanes are arranged so that air entering the opening which faces in the direction of motion of the car is forced through the ventilator and discharged through the opening facing towards side of car, this movement of the air creating a suction which draws the air out of the car interior through the deck window opening. The rush of air by the opening facing towards the side of the car also creates a suction which draws air from the car interior. The shape and design of interior vanes are such as to prevent entrance into the car of rain or snow.

Observing the objections to the automatic systems hereinbefore mentioned, ventilating systems have been developed which do not depend on the speed of the car and are not influenced by the velocity or direction of the wind. Among these systems are the Cooke and the Min-de-Lin-McGarry. Both of these systems depend on motor-driven fans for their operation.

The Cooke System consists of a motor-driven exhaust fan, located on the roof of the vestibule, exhausting air from the interior of the car by means of an exhaust chamber formed in the ceiling, and also drawing air from the vestibules by means of suitable ducts connecting with them. The action of the fan creates a partial vacuum in the car interior which induces a flow of fresh air through the intakes provided under the seats, the fresh air passing over the heaters before entering the breathing zone. The discharge opening of the fan is protected from wind, rain or snow so that the action of the fan is not affected by weather conditions or the speed of the car. The fan being motor-driven, the movement of air is positive and continuous during the operation of the motor.

The Min-de-Lin McGarry System consists of two motor-driven fan sets, one set located under each diagonally opposite corner seat. Each set consists of a motor having a fan on each end of the shaft, one fan drawing fresh air from the exterior of the car and discharging it over the heating coils to the interior, while the other fan on the shaft exhausts air from the car interior at a point near the ceiling and discharges it through the floor of the car. The heated air discharged into the car by the supply fans is distributed by means of ducts along each side of the car, having openings at various points along their length. Provision is also made to ventilate each vestibule.

The supply and discharge fans have protected openings, so that weather conditions do not affect their operation. The movement of air through the car is therefore positive and continuous during the operation of the motors.

From the above description it will be observed that the Cooke system has one motor while the Min-de-Lin McGarry system has two motors.

The action of motor-driven ventilating systems being continuous during operation of the motor, irrespective of the speed of the car or weather conditions, it would appear that they furnish ideal means for car ventilation. Unless, however, the motors and other operating parts are so constructed as to require little attention, the high cost of operation of motor-driven ventilating systems will make them undesirable from a practical standpoint.

The tests of the various ventilating devices mentioned herein have shown that most of them have considerable merit and all of them under certain conditions have shown ability to fulfil the requirements of the Department of Health. Further tests, however, are being made to determine which ventilating device will fulfil the requirements under all conditions, and yet have the elements of minimum maintenance and maximum life required to make it an operating success.

A Cable Counterweight System for a Steep-Grade on an Electric Railway at Seattle, Wash.

About twenty years ago, when electric traction was being introduced at Seattle, Wash., there was a question as to the safety of operating the steep-grade by which Washington Ave. ran down to the water front. A cable-counterweight system as an auxiliary for operating electric cars on steep grades was invented by Mr. J. P. Kuhlmann, civil engineer, of Seattle, and its first application (in 1891) was on this Washington Ave. grade. The length of line equipped with the system was about 1,000 ft., and its grades were from 11% to 16%. This installation was afterwards abandoned, and 16% grades in that city have been operated successfully by electric cars without any auxiliary system of control. The system has been introduced in other cities, as noted below.

There is in Seattle, however, a later line (with grades up to 18%) on which the counterweight system was first applied in 1900, and is still in use. This is the most important of all the systems of this kind which have been built. Its importance lies in its length, the steepness of its grade, and the use of two parallel and independent systems to give high traffic capacity on a double-track line. In its ten years of service it has proved satisfactory in regard to both efficiency and safety. It was installed, of course, to check descending and assist ascending cars, both to reduce the electric power required and to prevent accidents due to runaways. It differs from some of the earlier plants (noted below) in having a larger tunnel and larger counterweight car. For particulars concerning it we are indebted to Mr. Geo. P. James, Chief Engineer of the Seattle Electric Co.

The present installation of this cable-counterweight system is on a steep-grade portion of the West Queen Anne Ave. line. The length of the system is 2,600 ft. The grade of the street (and surface track) varies from 13.8% to 18.7% (reduced to about 8 or 10% at some street intersections), while the counterweight tunnels have a uniform grade of 13.7%. A part of the profile is shown in Fig. 1. As this is a double-track line, it

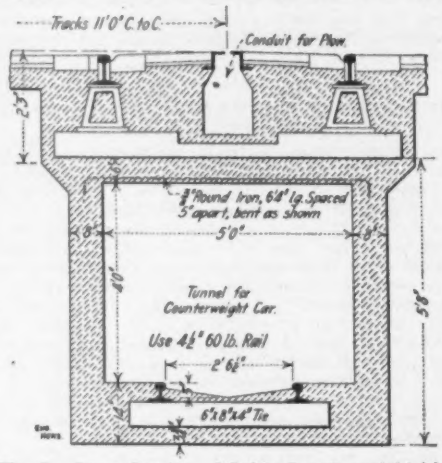


Fig. 2. Cross-Section of Cable Counterweight Line.

requires two independent counterweight systems. A 12-minute headway is maintained on each track, and the cars in each direction make five stops. The following description applies to the equipment for one track, and there is a duplicate equipment for the other track.

An endless cable is used. Its upper line, carrying the plow for the car connection, runs in a slotted conduit between the rails; the lower line, to which is attached the counterweight car, runs in a tunnel beneath the conduit, as shown in Fig. 2. At each end it passes over a 10-ft. sheave. One of these sheaves is mounted on a tension carriage. Clamped to the cable is a steel plow, Fig. 3. The body of this is a ¾-in. plate 20-ins. long, with a bar 1x1⅛-ins. riveted along each side at the top (outside of the conduit). Thus the top of the plow is a rib 2¾-ins. wide, and this is notched at the middle to receive the forked end of a hinged bar or finger carried by the car truck. This finger can be dropped to an inclined position so that its forked end engages with the slot in the plow. When thus engaged, the top of the plow is raised to the height of the finger in its normal position. The lowering and raising of the finger bar is done by the car conductor, by means of a lever projecting at the side of the truck.

The surface track has 7-in. 80-lb. T-girder rails, which are supported by iron chairs placed upon wooden ties in order to give the necessary height for the conduit. The slot in the street surface is formed by a pair of Z-bars. The track construction with rails on cast-iron chairs is now the standard for street railway tracks in Seattle, but the chairs are simply embedded in the concrete, no ties being used.

The tunnel for the counterweight car is 5 ft. wide and 4 ft. high, and is built of reinforced concrete. In the floor are embedded 4¼-in. 60-lb. T-rails for a track of 30-in. gage, the rails being spiked to wood ties 6x8 ins., and 4 ft. long, spaced 2 ft. c. to c. Each counterweight consists of two four-wheeled trucks coupled together and loaded with 5-in. slabs of cast-iron so as to make a total weight of 16 tons. The cable is attached at each end by means of a clamp bolted to the truck frame. One of the cars has a safety device consisting of horizontal cams with toothed surfaces, and these are held out of action normally by the tension of the cable, which is attached to a drawbar, as shown in Fig. 4. Should the cable break, heavy springs operating on levers revolve the cams so as to force their larger (toothed) faces against timbers on each side of the tunnel. This device had a practical trial some months ago, when a cable broke, and the counterweight car came to a stop in a distance of 4 ft.

The first of the two parallel counterweight systems was built in 1900, and the second in 1902. Both had timber-lined tunnels, but in 1908 the first one was rebuilt with reinforced concrete lining. This also has a tension carriage and weight at the lower end only.

There has been no trouble with the street cars running away. They are all equipped with air-brake equipment in addition to the ordinary hand brake, and two cars have been equipped experimentally with the Westinghouse magnetic traction brake as an additional safety device.

Other Cable Counterweight Inclines.

The Kuhlmann cable-counterweight system has been introduced in other cities, as mentioned above, and it will be of interest to give some brief particulars of these installations. Most of them have been described in more or less detail in our columns.* At Portland, Ore., it was first installed on Front St., the line being 550 ft. long, with grades of 12 to 14%. It was afterwards abandoned, however. About 15 years ago the Portland Ry., Light & Power Co. constructed a counterweight system for the operation of electric cars on a short grade of about 19%. This was on a line that ran up to City Park (a pleasure resort owned by the company) and was operated at that time with comparatively light electric cars. The operation of this line was entirely abandoned some years ago on account of its unprofitableness, and as it was on a private right-of-way, operation was not necessary to protect any franchises. We are informed that from a mechanical point of view it was a success. Being short (about 300 ft.) and at the end of a line, there was no difficulty in handling the traffic which existed at that time.

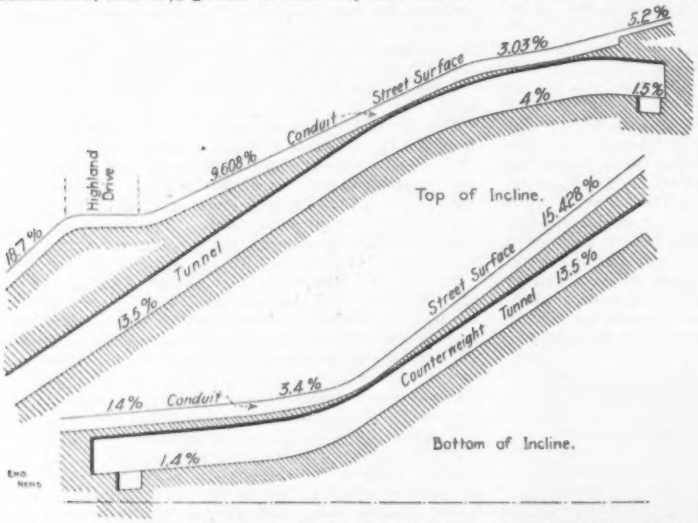


FIG. 1. PART PROFILE OF CABLE COUNTERWEIGHT INCLINE ON THE QUEEN ANNE AVE. ELECTRIC LINE AT SEATTLE, WASH.

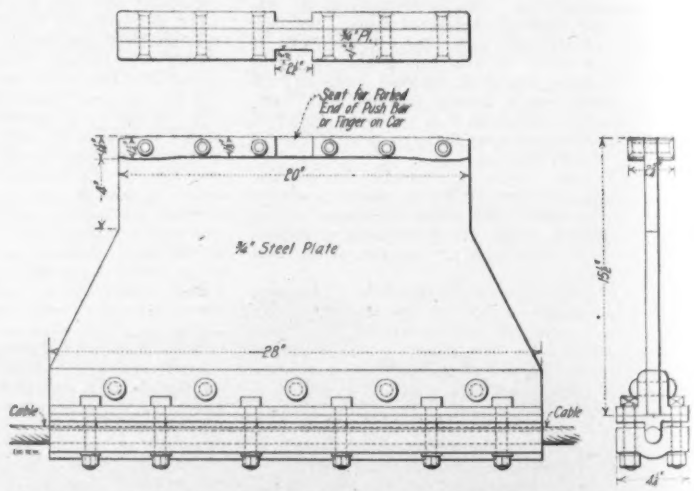


FIG. 3. PLOW FOR ENGAGING THE COUNTERWEIGHT CABLE WITH THE ELECTRIC CARS.

*References in Engineering News: Seattle and Portland, June 29, 1893, and Feb. 21, 1907. Providence, Oct. 11, 1894; St. Paul, Feb. 24, 1898, and Oct. 10, 1907. Sydney (Australia), Jan. 24, 1907.

All the cable line was done away with some six years ago and the company located its Portland Heights line without the use of any counterweight system or similar devices. Its electric cars operate over long and crooked grades up to a maximum of 12%. The line climbs over 1,000 ft. in about 1½ miles on a 25-minute run. The Westinghouse magnetic brakes are used and have proved very satisfactory. On the steepest grades there are a number of derailing switches so located as to make it necessary to bring the car to a stop at such points and for the conductor to hold the switch closed while the car is going through. The company states that it has never regretted eliminating all counterweights or slot devices, and adhering to ordinary street electric railway operation with additional protective devices.

At St. Paul, Minn., the Kuhlmann counterweight system was installed on a grade of 16% when electric traction superseded cable traction; but in 1907 this grade was reduced to 7% by building a tunnel under the street, so that there was no further necessity for the counterweight system. At Providence, R. I., it was installed on a line having an average grade of 14% and maximum grade of 17½%. About four years ago a similar system was installed at Sydney, New South Wales, for a grade of 10 to 12.13%, 600 ft. long, leading down to the water front. The traffic capacity was said to be only three cars per hour, or one car every 20 mins.

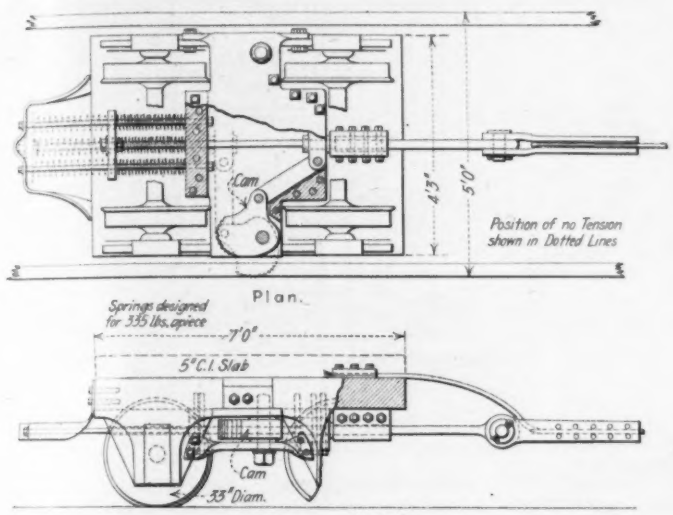


FIG. 4. COUNTERWEIGHT CAR FITTED WITH SAFETY STOP.

THE GROWTH OF THE COTTON SEED PRODUCTS industry is shown in a recently issued bulletin of the Bureau of the Census, giving a comparative summary for the years 1899, 1904 and 1909. This summary shows a remarkable development, the number of establishments having increased during ten years from 357 to 809, or 127%. This increase has been very general throughout the cotton states. The quantity of cotton seed crushed increased only 54%, while the price paid by the manufacturer increased 173%, showing that the cotton grower was the chief gainer. The total value of the crude products in 1909 was $107,538,000, an increase of 154% over the figures for 1899.

While the increase in the quantity of seed crushed was only 54%, the production of oil increased 70%, owing to improvements and economies in manufacture. Another interesting feature is the increase of 200% in the quantity of linters saved from reginning the seed for oil extraction. The linter fiber itself now finds a ready market on account of the high price of cotton. A double economy was thus effected.

The value of the crude oil represents about 50% of the total value of the products. The uses to which the oil has been put have greatly extended. It has now become so important a food product, as a substitute for lard, that the price of oil now fluctuates with the price of hogs. In 1900 only 29% of the oil was exported against 54% in 1899. Yet, notwithstanding the fact that the quantity exported in 1900 was less than that in 1899, its value was $7,000,932 greater.

Concrete Street Paving In Mason City, Ia.*

By F. P. WILSON.†

During the past five or six years I have made a broad study of cement paving. I have visited a large number of cities in the northern states where this class of pavement has been laid, and have watched the methods of construction.

It is my opinion that a Portland cement concrete pavement, properly laid with first-class materials, and having proper allowance made for expansion and contraction, certainly warrants its use on account of its first cost, cheapness to maintain, the cleanliness of the streets, and the small expense to repair where it becomes necessary to cut holes.

During the summer of 1900, Mason City, Ia., laid 6,000 sq. yds. of cement paving in the down-town district, where it would have a test under the most severe traffic. At this time, after standing the severe test of two winters and heavy traffic last year, it is in as good a condition as the day it was finished. During the past season 25,000 sq. yds. were laid, and contracts have been let for 43,000 sq. yds. which this city expects to have laid next summer.

In constructing a first-class cement pavement, the requirements are (1) strictly first-class material, (2) first class plans and specifications, and (3) a rigid and close following of these specifications in every detail. Appended are the specifications which I have used in the construction of all concrete paving laid in Mason City. They were followed very closely in every detail and have proved entirely satisfactory.

In this work 12,000 barrels of Northwestern States Portland cement were used. From every car ten samples were taken, tests were made for fineness, tensile strength and specific gravity, also boiling tests were made. A Koehring concrete mixer was used having a 25-ft. boom, with a traveler.‡ After the sub-grade had been thoroughly rolled the material was distributed along the street, the stone on one side and the sand on the other. The mixer was set up at the end of the street, 25 ft. from the place of beginning. In the first section, 12½ × 30 ft., the concrete was placed. Immediately the wearing surface was placed upon the concrete, not more than 20 mins. elapsing between the time the concrete was placed and the wearing surface was laid upon it. Then the next section of 12½ × 30 ft. was put in. Then the mixer propelled itself backwards 25 ft. and the work proceeded as before.

Parallel with the curb, and 10 ft. from it, the wearing surface was cut through into the concrete. These parallel cuts were 10 ft. apart, so that our actual blocks of concrete are only 12½ × 10 ft.

Some of the streets were very soft and swampy. To obtain a dry and well drained sub-grade, a trench was excavated parallel with the curb, on each side of the street, 18 ins. out from the curb and 18 ins. below subgrade. A 4-in., tile drain was laid and connected with the sewers. The earth excavated from the trenches was hauled away and the trenches were refilled with good, clean, hard-burned cinders, making a thorough drainage for the sub-grade.

The contract price for these cement pavements, including excavation, was $1.25 per sq. yd. The cost to property owner was 5 cts. per sq. yd. in addition to the contract price, which includes the cost of engineering, inspection, advertising and levying the assessment.

Specification for Concrete Paving.

Preparation of Roadbed.—All streets, prior to laying any pavement thereon, shall be so graded that the pavements will be at the established grade when completed. After excavating to subgrade, unless the engineer deem the natural ground a proper foundation, excavation shall be continued until solid ground is reached and then refilled to subgrade with sand, gravel or broken stone. The contractor shall be required to remove at his own expense all obstructions, such as trees, old blocks, debris, etc.

Excavation.—All excavated material, gutter stones, planks, macadam, crossing-stones, old curbs, surplus earth, etc., shall be the property of the city and be deposited by the contractor in such place and manner as shall be directed by the engineer, the distance not to exceed 3,000 ft. No plowing will be allowed within 3 ins. of the bottom of the foundation.

Rolling—When the street shall have been graded and shaped to its proper form, it shall be thoroughly rolled with a 10-ton roller to a thoroughly compact surface. If the ground is wet, sand or gravel is to be put in before rolling. Any depression discovered after this rolling, shall be refilled to subgrade, rerolled, and this repeated until a roadbed, perfect as to grade and form, shall have been made.

Tamping.—When the use of the roller is impracticable, the foundation must be thoroughly puddled and rammed until compacted to the satisfaction of the engineer.

Concrete Foundation.—Upon the roadway thus formed, will be laid Portland cement concrete 5 ins. thick, to be made as follows: 1 part by measure of Portland cement; 2 parts of clean, sharp sand, and 5 parts of broken stone.

The sand and cement shall be thoroughly mixed dry, on a tight floor, and then made into mortar at the proper consistency and thoroughly mixed over with hoes or shovels; or a batch mixer may be used, approved by the engineer. Broken stone, thoroughly cleaned of dirt, drenched with water but containing no loose water in the heap, shall then be added to the mortar in the proper proportion. The concrete will then be turned and mixed until each fragment is thoroughly coated with mortar, a strictly wet mixture being required. The concrete thus mixed shall have such a consistency that when rammed the mass will not shake like jelly, but will, when struck, compact within the area of the face of the hammer without displacing the material laterally.

The concrete thus prepared shall be placed immediately in the work. It shall be spread and thoroughly compacted by ramming until free water appears on the surface, which shall be made smooth and parallel to the surface of the finished pavement. The whole operation of mixing and laying each batch of concrete shall be performed in an expeditious and workmanlike manner and be entirely completed before the cement has begun to set. No retempering of concrete will be permitted, and concrete in which the mortar has begun to set will be rejected.

The thickness of this concrete to be 5 ins. after it has been compacted.

Extreme care should be taken that the subgrade is kept moist while this concrete is being put in place. No concrete shall be laid when the temperature at any time during the day or night falls below 35° F.

Wearing Surface.—Upon the concrete base shall be laid immediately a wearing surface 2 ins. thick, made as follows: 1 part by measure of Portland cement, 2 parts of coarse, clean, sharp sand. The sand and cement shall be thoroughly mixed dry, on a tight floor, and then made into mortar of the proper consistency and thoroughly mixed over with hoes or shovels, or a batch mixer approved by the engineer. The mortar thus mixed will be immediately laid upon the concrete. Before this mortar has begun to set it will be finished off to a smooth surface and corrugated according to the plans.

Corrugations.—After the wearing surface has been completed the same shall be corrugated at an angle of 90° with the curb, said corrugations to be 9 ins. apart and ⅝-in. deep. They shall be formed with proper tools made for the purpose, and when the pavement is complete the corrugations shall present a slightly rounded upper edge so as to provide a firm and substantial foothold for the horses, no sharp corners to be left.

Where the street has a flat grade, the City Council may omit the corrugations. The wearing surface shall then be finished with a wood float and before it has completely hardened, it shall be roughened by brushing with a stiff vegetable brush or broom.

The curvature and cross sections of the pavement to be made according to the plans governing the same.

Materials.—The cement will be submitted to the tests approved and recommended by the American Society of Civil Engineers, which it must stand to the satisfaction of the engineer. All Portland cement used in the work shall be Northwestern States Portland cement or other Portland cement equally as good, which shall be protected from the weather, free from exposure to air slacking and from moisture until used.

The sand shall be clean, sharp sand. The stone for the concrete shall be of the best quality of hard limestone, or other stone equally as good, and shall be broken to such a size that the fragments shall not be larger than will pass through a 1½-in. ring and not smaller than a hazel nut. It shall be free from dust, dirt, loam or other objectionable material and shall be screened when necessary over a ½-in. screen to eliminate dust and small particles.

Expansion Joints.—An expansion joint 1 in. wide shall be left next to the curb on each side of the street or alley; also an expansion joint ½-in. wide will be left every 25 ft. at right angles to the curbs. The expansion joints are to be filled with an asphalt paving filler of proper quality and consistency. This will be applied while heated to a temperature of about 400° F., and shall be so applied that the expansion joints shall be thoroughly filled to the top of surface of the pavement.

All forms for expansion and contraction joints shall be made of iron or steel in the form of a template, cut to the desired shape of the street according to the plans, and of sufficient strength to resist springing out of shape. All mortar and dirt shall be removed from forms that have been previously used. The forms shall be well staked to the established lines and grades.

Contraction Joints.—Contraction joints shall be made entirely through the pavement every 12½ ft., at right angles with the street.

The edges of all expansion and contraction joints shall be rounded to a radius of about ½-in. with proper tools. Care shall be taken to obtain a surface free from ridges at expansion or contraction joints, and depressions or unevenness in the surface, that will detract from its appearance, or cause water to lay on the pavement. Any section having such inferior surface will be rejected, and shall be rebuilt by contractor at his own expense.

Care shall be taken to make the expansion joints in such a manner that they are practically the same width throughout their depth.

Extreme care must be exercised in removing templates or divisions used to make expansion or contraction joints; the breaking out of any portion of the pavement, in removing such templates and forms, will not be tolerated, and such damaged portions of the work shall be torn out and replaced in good condition by the contractor at his expense.

The contractor shall keep the pavement sprinkled for one week after it is laid, or longer if deemed necessary by the engineer. The contractor shall keep the streets barricaded at least two weeks after the completion of the pavement.

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*Abstract of a paper presented at the annual meeting of the Iowa Engineering Society at Des Moines, Ia., Feb. 15-17. An extended article on the use and construction of concrete paving was published in our issue of Aug. 20, 1908.

†City Engineer, Mason City, Ia.

‡A dump bucket is carried by this traveler or trolley, which is operated by a cable. The bucket is loaded directly from the mixer, and run out to any desired position on the horizontal boom to dump the concrete in place. The boom can be swung laterally.—Ed.

Arresting the Flow of a Large Tidal River: The Charles River Dam.

By J. ALBERT HOLMES.*

Much has been written regarding the earth dam across the Charles River, between the cities of Cambridge and Boston, Mass., and the structures in connection therewith.† The most interesting and unusual feature of the work was the building and successful closing of a so-called shut-off dam, whereby the tidal flow over an area of 830 acres was arrested in a few seconds. To quote from the specifications:

> The main portion of the dam is to be constructed of earth filling between masonry retaining walls supported on pile foundations and extending to and connecting with existing walls [and] from the lock to the sluices on the Cambridge side there is to be constructed a so-called shut-off dam, for the purpose of arresting the tidal flow.

The "Lock," 45 ft. wide, 352 ft. long, between faces of gates, with 17 ft. of water over the lower sill at mean low tide, was built of concrete masonry within a cofferdam having an area of 3.8 acres, located near the Boston shore of the river.

The lock is for the purpose of passing traffic to and from the wharves, most of which are located on two canals leading from the basin.

The structure called the "Sluices" was also of concrete, and was built within a cofferdam having an area of 1.2 acres, located near the Cambridge shore. Through the sluice structure are eight 7½ × 10-ft. discharge sluices for controlling the fresh-water flow of the river; there is also a lock for small boats and a storm-water outlet for the Cambridge sewers.

East of the lock and west of the sluices, and between the lock and sluices, the earth fill of the main portion of the dam was made, the depth ranging from 10 ft. at the shores to 30 ft. in the deeper portions of the river, and having a minimum width of 340 ft.

The work of building the two cofferdams shown on the plan, Fig. 1, began in March, 1905. The

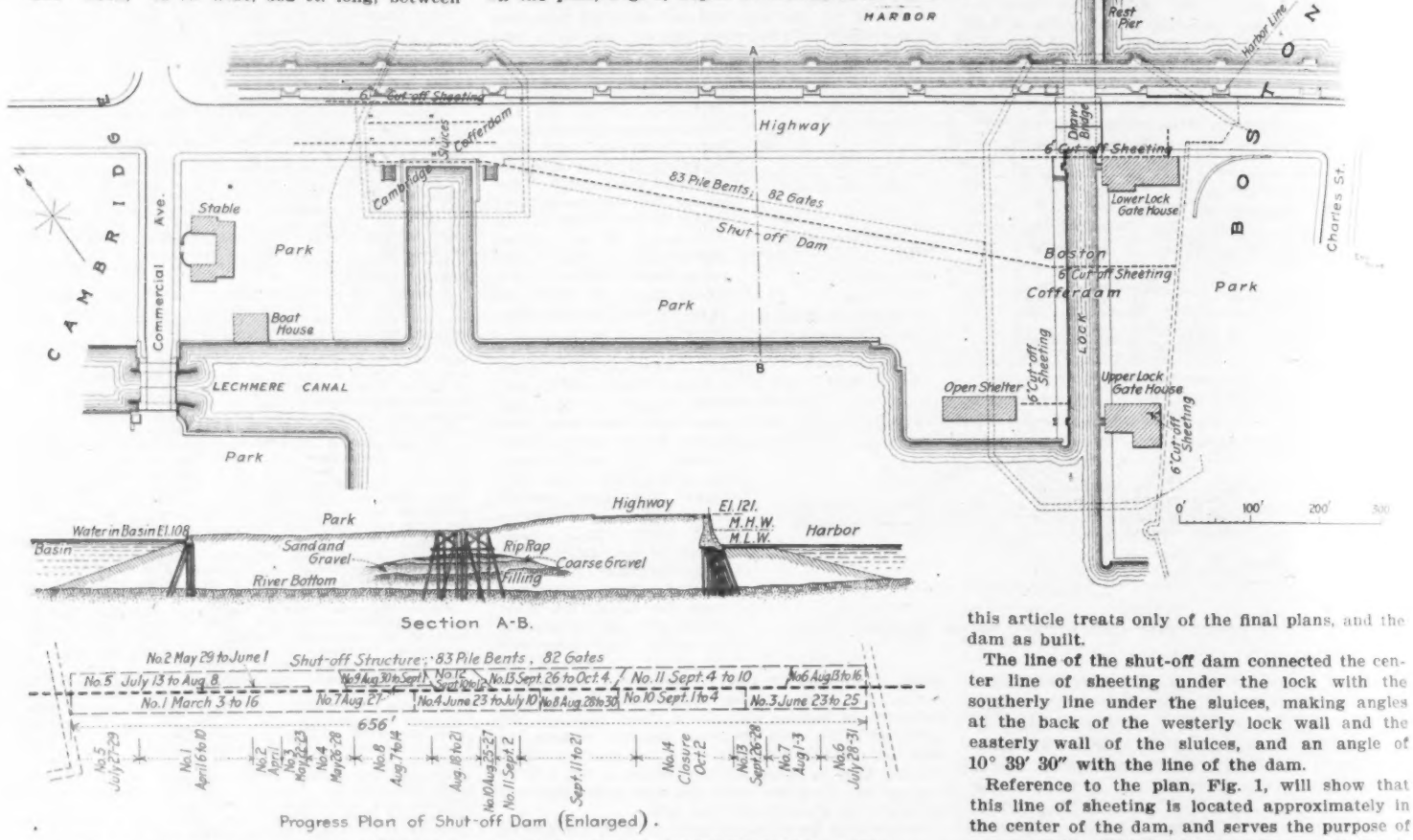

FIG. 1. OUTLINE PLAN OF CHARLES RIVER DAM, BOSTON-CAMBRIDGE, MASS., WITH CROSS-SECTION.

structures within the cofferdams had been so far completed that on Sept. 1, 1908, the ends of the dams having been removed, the lock was opened to navigation, though the lock gates were not operated until Oct. 20, 1908. After pumping out and previous to building the lock in the Boston cofferdam, three lines of 6-in. grooved and splined hard pine sheeting were driven, and under the sluices, in the Cambridge cofferdam, four lines were driven for the purpose of cutting off any possible flow under these structures. The location of this cut-off sheeting is shown on the plan, Fig. 1.

Each line was driven through sand and gravel, and an underlying stratum of coarse gravel, into the clay beneath. To assist in driving the four lines at the sluices, through the gravel layer, a water jet was used. Where the sheeting came in contact with the bottom and sides of the lock and sluice structures, it was embedded 9 ins. in the concrete.

The shut-off dam was originally designed to extend from the back of the west wall of the lock to the easterly wall of the sluices, a distance of 816 ft., in which distance there would have been 103 bents, 8 ft. c. to c. The bents were numbered from the Boston end of the dam. This plan involved the removal of a portion of each cofferdam. The plan was changed and the single line of 6-in. sheeting, without the pile bents and gates, was extended to the outer line of sheeting of both the Boston and Cambridge cofferdams, and to compensate for the reduced width the vertical sheeting was cut 1 ft. lower, or at Elev. 97.0, with the exception of 88 ft. near the Boston end, which was cut at Elev. 102.0.

The dam as built consisted of 83 bents and 82 gates; the bents were numbered from 13 to 95, inclusive, and the gates from 13 to 94; the bents not built in the Boston cofferdam being No. 1 to No. 12, and those not built in the Cambridge cofferdam being No. 96 to No. 103.

There were a number of changes in the plans of the shut-off dam, as originally designed, but this article treats only of the final plans, and the dam as built.

The line of the shut-off dam connected the center line of sheeting under the lock with the southerly line under the sluices, making angles at the back of the westerly lock wall and the easterly wall of the sluices, and an angle of 10° 39′ 30″ with the line of the dam.

Reference to the plan, Fig. 1, will show that this line of sheeting is located approximately in the center of the dam, and serves the purpose of a core wall. Details of one bent are shown in Fig. 2. All bents were alike.

Each portion of the structure will be described in the order in which it was built.

The cross-section of the river below mean high tide had been reduced by the construction and filling of the cofferdams 43% at the time the work of driving piles for the shut-off dam began, early in March, 1908.

The cross-section of the river had been reduced at the moment of dropping the gates to about 4,000 sq. ft. or 15% of the original section up to Elev. 106.5, the point at which the tide stood when the gates were dropped; this point being about 4 ft. below mean high tide.

The method of constructing the shut-off was as follows: All the piles, vertical and spur, were driven in a portion of the up-stream half of the dam, beginning near the Cambridge shore. These piles were fitted, bolted, capped and braced, and two double lines of guide walings bolted on the down-stream side; the upper at Elev. 110.0; the lower at Elev. 102.0 along the center line of the dam (see Fig. 4). The piles were driven with a floating machine. The handling of caps and bracing was done by a small derrick lighter; the horizontal and diagonal braces could be placed only at low tide.

Air for boring was furnished by a compressor plant set up on the Cambridge cofferdam, with a supply pipe laid along the shut-off dam. The method of driving sheeting is very well illustrated in Fig. 4. After placing the double rows

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†The following is a list of previous articles on this subject published in Engineering News:

The New Charles River Dam and Basin at Boston, Mass. By J. Albert Holmes, Div. Engr., Oct. 6, 1904, p. 305.

The Charles River Dam and Basin at Boston and Cambridge, Mass. By J. Albert Holmes, Div. Engr., Jan. 12, 1905, p. 31.

Construction Work on the Charles River Dam and Basin, at Boston, Mass. By J. Albert Holmes, Div. Engr., March 1, 1906, p. 243.

Experiments on the Amount of Heat Required to Prevent Ice Formation on the Steel Lock Gates of the Charles River Dam. By Walton H. Sears, Mech. Engr., March 15, 1906, p. 287.

The Lock Gates at the Charles River Dam, Boston and Cambridge, Mass. By Edward C. Sherman, Div. Engr., July 9, 1908, p. 27.

The Closure of the Charles River Dam. By Edward C. Sherman, Div. Engr., Nov. 5, 1908, p. 498.

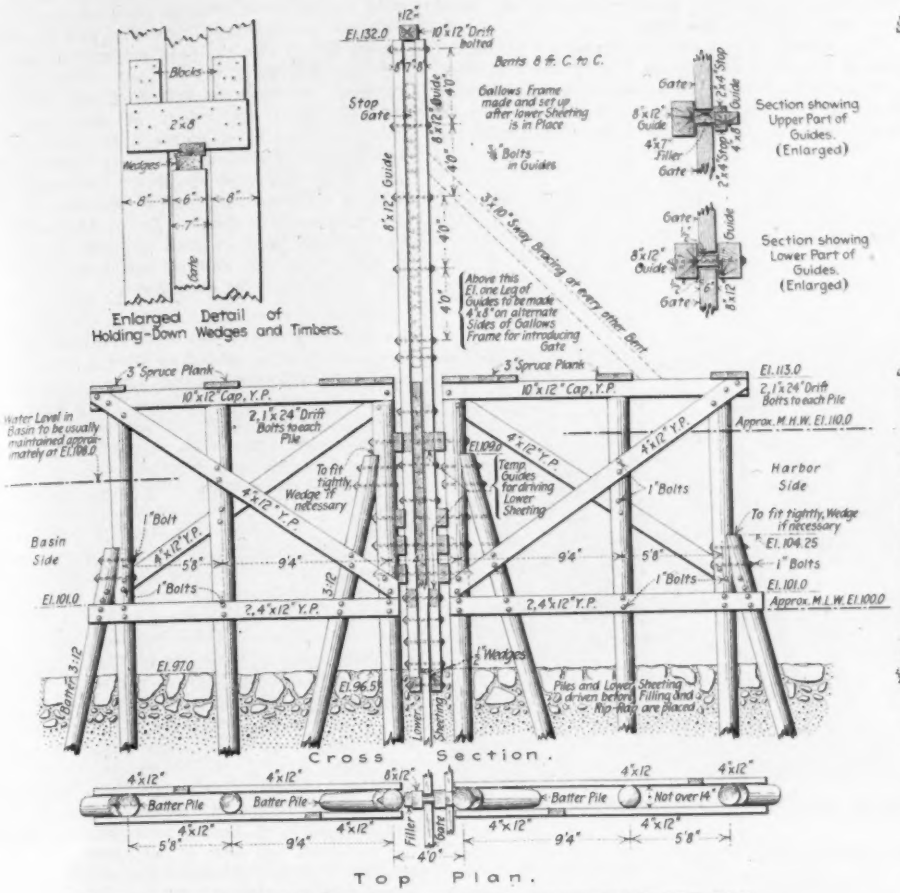
The Cast-Iron Gates for the Fens Gate Chamber, Charles River Basin, Boston, Mass. By Walton H. Sears, Mech. Engr., Feb. 25, 1909, p. 222.

Experiments on the Corrosion of Steel in Contact with Bronze in Sea-Water. By Edward C. Sherman, Div. Engr., March 18, 1909, p. 292.

Crushing Tests on Water-Soaked Timbers. By Edward C. Sherman, Div. Engr., July 1, 1909, p. 22.

Distribution of Sea-Water in the Charles River Basin, after Excluding Tidal Waters. By Morton F. Sanborn, Asst. Engr., March 10, 1910, p. 272.

Some Notes on Sliding Sluice Gates, Charles River Basin, Boston-Cambridge, Mass. By Walton H. Sears, Div. Engr., May 26, 1910, p. 615.


Enlarged Detail of Holding-Down Wedges and Timbers.
Blocks
Wedges
Gate
Stop Gate
Gallows Frame made and set up after lower Sheeting is in Place
Section showing Upper Part of Guides. (Enlarged)
Section showing Lower Part of Guides. (Enlarged)
3"x10" Sway Bracing at every other Bent
3"Spruce Plank
10"x12" Cap, Y.P.
2,1"x24" Drift Bolts to each Pile
Water Level in Basin to be usually maintained approximately at El. 108.0
To fit tightly, Wedge if necessary
Temp. Guides for driving Lower Sheeting
Harbor Side
Basin Side
1"Bolt
1"Bolts
2,4"x12" Y.P.
Approx. M.H.W. El. 110.0
Approx. M.L.W. El. 100.0
El. 97.0
Piles and Lower Sheeting driven before Filling and Rip-Rap are placed
Cross Section.
Batter Pile
Not over 1/4"
Filler
Top Plan.

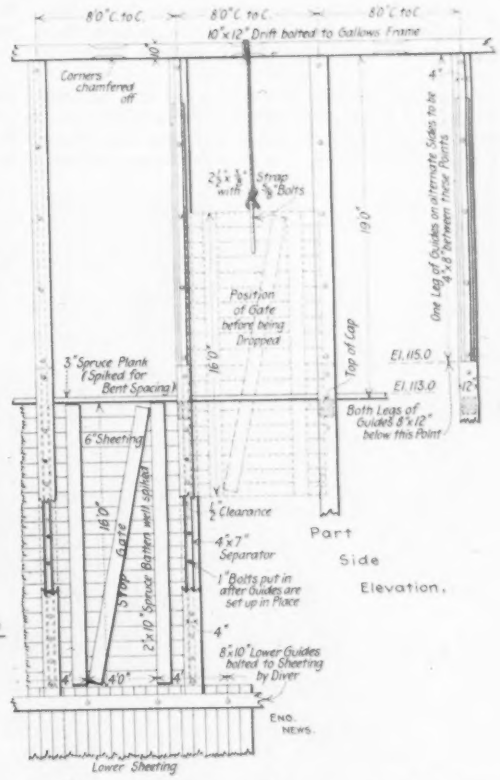

10"x12" Drift bolted to Gallows Frame
Corners chamfered off
Strap with 3/4" Bolts
Position of Gate before being Dropped
3"Spruce Plank (Spiked for Bent Spacing)
6"Sheeting
Top of Cap
El. 115.0
El. 113.0
Both Legs of Guides 8"x12" below this Point
One Leg of Guides on alternate Sides to be 4"x8" between these Points
1/2" Clearance
4"x7" Separator
1"Bolts put in after Guides are set up in Place
Stop Gate
2"x10" Spruce Battens well spiked
8"x10" Lower Guides bolted to Sheeting by Diver
Part Side Elevation.
Lower Sheeting

FIG. 2. DETAIL OF ONE BENT OF CHARLES RIVER SHUT-OFF DAM.

(Reproduced, with amendments, from Engineering News of Nov. 5, 1908.)

of guide waling, a land machine having extension gins was placed on the completed structure, and a piece of sheeting driven to the upper waling, plumbed and bolted into position, after which sections from 12 to 96 ft. long were set up and driven to the same elevation.

The upper waling was then removed, and the sheeting driven down to the lower waling; the top of the sheeting being left at about Elev. 102.5; then the permanent 8 × 10-in. double line of waling was placed, with the assistance of a diver, with its top at Elev. 96.5, and bolted securely in place.

The ordinary fill (Fig. 3) had been placed up to Elev. 84 before pile driving began, and now the sand and gravel layer was put in up to Elev. 92 to support the sheeting, after which the lower line of temporary waling was removed and the sheeting sawed off at Elev. 97 by a diver; or a longer stretch was cut off by a floating pile-driving machine, carrying in its gins a circular saw on a vertical shaft. The waling was then unbolted and the whole section removed,

Following this, the piles were driven in the down-stream half of the structure, the spur piles fitted and the bents capped and braced.

While the work of pile driving had been going on, other carpenters were engaged in assembling the guides, which were made up of two pieces of 8 × 12-in. hard pine, one 35 ft. 6 ins. long and the other 18½ ft. long. Between these was bolted a 4 × 7-in. throat piece, and in extension of the shorter 8 × 12-in. piece was placed a piece of 4 × 8-in. stuff. The lower end of these guides rested on the double 8 × 10-in. waling at Elev. 96.5, astride the 6-in. vertical sheeting.

The side having the 4 × 8-in. piece alternated from the up-stream to the down-stream side of the dam. This was to permit rotating the gates into place in the guides, after which 2 × 4-in. stops were spiked to the 4 × 8-in.

The note on Fig. 2 refers to the making and placing of the guides, where it says, "Above this Elev. (115.0) one leg of guides to be made 4 × 8-in. on alternate sides of gallows frame for introducing gate."

The setting up and securing in place of these guides followed the completion of each portion of the down-stream half of the dam, after which the coarse gravel was put in up to Elev. 95.0, and on this was placed the rip-rap to the top of the vertical sheeting at Elev. 97.0, sloping either way from the sheeting—1 ft. in the first 20 and 3 ft. in the next 20 ft., the total width of rip-rap being 80 ft.

The rip-rap consisted of quarry debris and was placed directly from lighters and schooners, the larger blocks being lowered into place and the finer dumped from skips. The weight required for the larger stones was from 500 to 3,000 lbs., in the interstices of which the smaller stones were deposited.

Boring for the long 1-in. bolts which pass through each guide, the two adjacent piles, and the intervening blocking, was a very nice piece of work.

These bolts were about 6 ft. in length, and had a nut and washer on each end; their function being to hold the guide in position between the two parts of the bent, and with the aid of the blocking to communicate the load from the gates to the pile structure.

The boring was done with an air-driven machine, using a bit having a long shank. To insure the hole passing through the center of the 4-in. throat piece, which was the difficult part of the operation, a guide board, extending beyond the spur pile, was attached to the guide, the plane of the edge of the board passing through the center of the 4-in. throat piece. The auger was held against the edge of the guide board until the boring had passed beyond the throat piece. Three of these holes passed through one spur pile (see Fig. 2).

The numbered and dated areas on either side of the center line of the shut-off structure, Fig. 1, show the sequence of the pile-driving operations, and the dates below show the location, extent and time of driving each section of vertical sheeting.

The final closure in the vertical sheeting was made on Oct. 2, 1908, in ten bents, Nos. 27 to 37 (see Sec. 14, Fig. 1, marked "Closure").

These bents were in what had been the ship

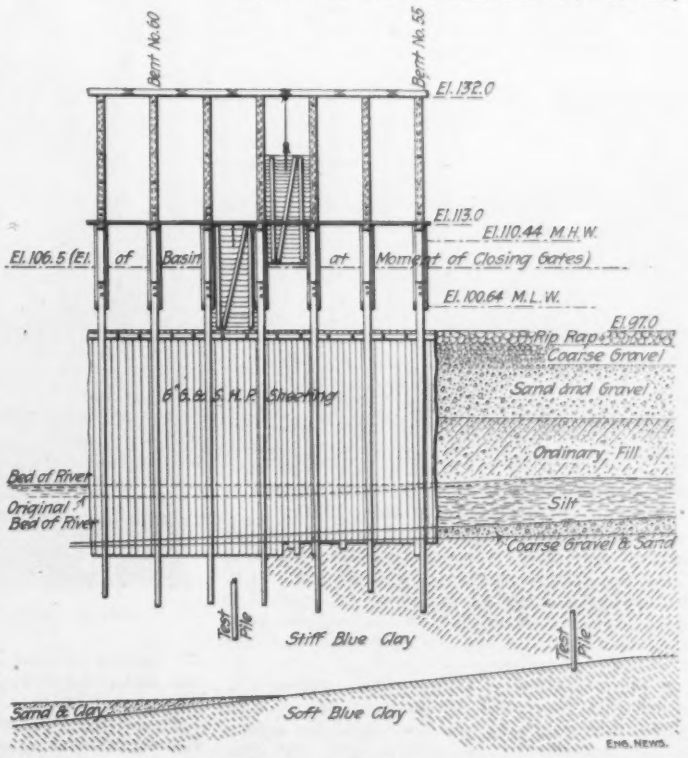


FIG. 3. ELEVATION OF PART OF CHARLES RIVER SHUT-OFF DAM AND SECTION OF FILL.

channel up to the time of opening the lock to navigation on Sept. 1; the piles having been driven here between Sept. 1 and 10 (areas 10 and 11, Fig. 1).

Following the pile work and bracing in these areas the lower temporary walings only were placed at Elev. 102.0, between which was driven a single extra long piece of sheeting opposite

FIG. 4. VIEW OF UP-STREAM HALF OF CHARLES RIVER SHUT-OFF DAM, LOOKING EASTERLY.

each pile bent. Sections of sheeting to exactly fill the spaces between the single pieces were made up and battened together ready for placing and driving.

These ten sections were set in place by a lighter, beginning at half ebb tide in the early morning of Oct. 2. Each section was supported on a short brace placed on top of the waling, and under the lower batten on the sections of sheeting. These braces were knocked out simultaneously, the sections allowed to drop to the river bottom, and in the space of one hour and forty minutes the 80 ft. was driven down to just above the lower waling at Elev. 102, using two pile drivers, one working from the middle of the closure toward one end, and the other beginning at the other end and working toward the middle.

One set of 8 × 10-in. permanent waling was put in and the sheeting cut down to Elev. 97, in two bents; after which any further cutting at Elev. 97 had to be abandoned because of the strong currents.

The sheeting in three other bents had been left above Elev. 102.0, so that after cutting down two bents in the closure section there remained eleven bents in which the sheeting was still above Elev. 102.0.

The temporary walings in these bents at Elev. 102.0 were bolted permanently in that position, and the sheeting sawed off flush with their top sides. For this reason eleven gates and guides were built 5 ft. shorter.

The work of placing gravel and rip-rap was next finished for the entire length of the dam. The rip-rap along the high portion was composed of extra large blocks and was carried up to the top of the sheeting at Elev. 102.0.

The gates were built up of 6-in. grooved and splined hard pine, battened together with three 2 × 10-in. spruce planks. The gates were 16 ft. high (11 were only 11 ft. high), and varied in width from 6 ft. 4 ins. to 9 ft. 7½ ins.; the average being 7 ft. 6½ ins., or 1 in. less than the space between guides.

It was not possible in the swiftly running tide to drive the piles with the exact spacing of 8 ft. It was, however, very important that the guides be set perfectly plumb, and in line with the bents. This could be very readily accomplished because of the firm footing on the vertical sheeting, and the opportunity to brace from the pile structure, though the guides were not in exact line lengthways of the dam.

The rip-rap was carefully examined along the line of the vertical sheeting during the low tides, just previous to the day on which the gates were dropped, and removed where it had washed off to the sheeting; afterwards a diver examined the sheeting in each bent and removed all obstructions.

Each gate was tested by lowering into position on the vertical sheeting, examined by the diver and a mark made on the guides that would show the gate had gone to its proper bearing when finally dropped. After testing, the gates were suspended by 1¼-in. ropes from the 12-in. cap on top of the guides, and on the morning of Oct. 20 lowered to about 1 ft. above the surface of the water, as it would stand at the moment of dropping the gates.

Elevations taken on the vertical sheeting after sawing showed some slight irregularities. To overcome this difficulty, second-hand rubber hose was nailed to the bottom of each gate. A section of T-iron attached to the bottom of each gate would have made a more effectual closure between the bottom of the gate and the vertical sheeting, but the old hose served the purpose.

To secure the gates in place after they were dropped, blocks were spiked to the guides on each side of the groove; four to each gate. Two pieces of 2 × 8-in. plank 2 ft. long and four wedges were made; the plank to be thrust under the blocks and over the gate; the wedges to be driven between the top of the gate and the lower edge of the plank. The planks and wedges were laid on the 3-in. deck adjacent to the guides on the up-stream side of the dam; two planks and four wedges to each gate.

Oct. 20 was the day and 10 a. m. the hour set for dropping the gates and arresting the tidal flow. To prevent filling or rip-rap being washed over the vertical sheeting at the last moment, it was thought best to lower four of the gates, one at each end of the dam next the cofferdams and the high gates at each end of that part of the vertical sheeting, cut off at Elev. 102.0.

The rope supporting the first of these four gates, No. 35, was cut and the gate dropped by the writer at 8.15 a. m., Oct. 20, and later the other three were dropped and secured in place. To one of the low gates, No. 24, had been attached an apparatus for dropping the gate electrically.

At 10 a. m., the time set for dropping the gates, a strong northeast wind was blowing. This held the tide up higher than it was desired to have it above the dam after closing. An hour later the water above the dam having dropped to Elev. 106.5, word was passed, the Governor of the State, Hon. Curtis Guild, Jr., blew a small whistle as a preliminary signal; one of the Commissioners, Joshua B. Holden, closed a switch and dropped gate No. 24. At the same moment the five-year old son of the writer pulled the cord of a larger whistle as a signal to the 40 men on a staging at the top of the guides to swing their axes right and left, and each to cut the suspending ropes of two gates. In two minutes' time the gates were down, the holding-down pieces in place, and the wedges driven home. No obstructions got on the vertical sheeting and each gate went down to the mark, showing that the careful preparation was rewarded by complete success.

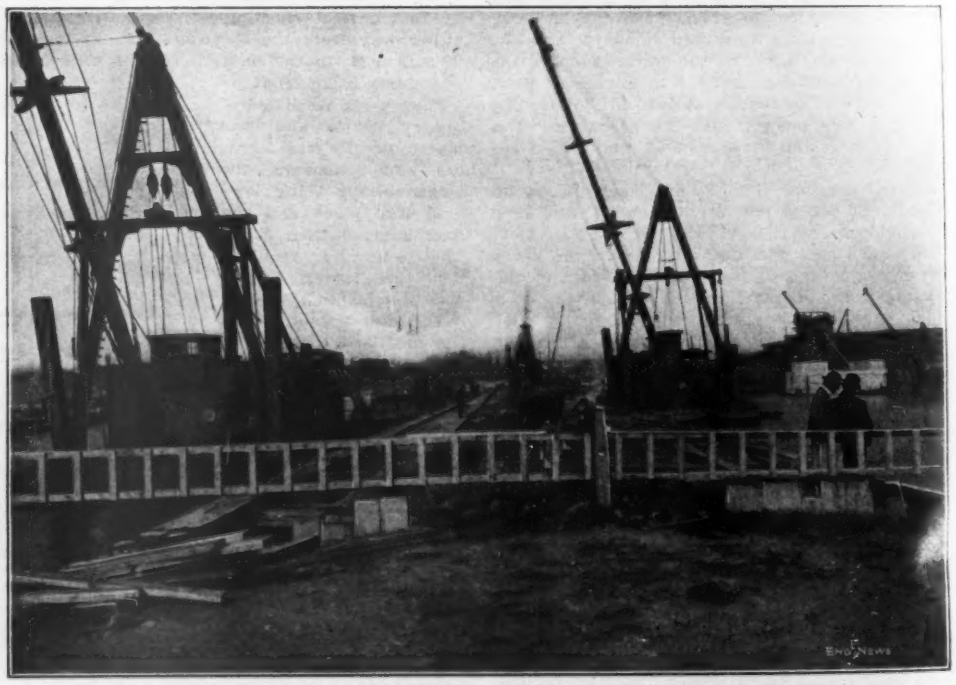


FIG. 5. VIEW OF CHARLES RIVER DAM THE DAY AFTER CLOSING THE SHUT-OFF.

Three rehandlers began at once to pile material against the gates. Additional material was brought in scows from dredges excavating in the basin and dumped in reach of the rehandlers.

Saw cuts had been started in the guides be-

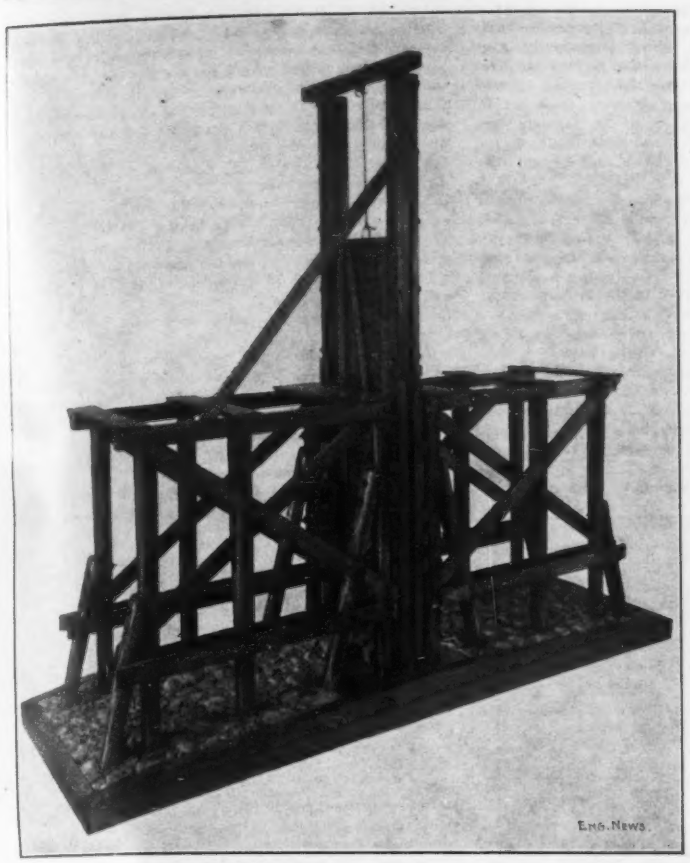


FIG. 6. MODEL OF TWO BENTS AND ONE GATE OF THE CHARLES RIVER DAM.

fore the gates were dropped; as soon as the gates had been secured in place the guides were cut off at Elev. 115.0 to allow the buckets of the rehandlers to swing over the structure.

Fig. 5 is a view of the dam Oct. 21, the day after closing. The engineers in line with the bucket are testing the center line for movement; with the greatest difference of head which occurred immediately after the dam was closed and before much filling had been placed, the movement was less than an inch either side from the center line, or a total movement of less than 2 ins. at Elev. 115.0.

Fig. 6 is a view of a model of two bents and one gate of the dam, showing the bracing and bolting, and the relation of the rip-rap to the lower horizontal bracing.

Fig. 7 shows a general view of the Boston end of the Charles River Dam after completion, showing the highway, the lock, the lock gate houses and the open shelter.

The following quotations are from the specifications covering the materials used in the dam:

All round piles shall be of long leaf yellow pine or oak. They shall be winter cut from straight live timber, free from large or decayed knots, wind shakes or other defects impairing their strength. They shall be not less than 12 ins. in diameter, 3 ft. from the butt, and not less than 6 ins. in diameter at the small end, all dimensions being exclusive of bark. Provided, however, that spruce or Norway pine piles may be used in accordance with the above specifications, except that the piles shall be not less than 7 ins. in diameter at the small end and the vertical piles shall be not less than 13 ins. in diameter 11 ft. from the butt. The inclined piles to be cut off at Elev. 109 shall be not less than 13 ins. in diameter 8 ft. from the butt, and the inclined piles to be cut off at Elev. 104.25 shall be not less than 13 ins. in diameter 4 ft. from the butt, all dimensions to be exclusive of bark.

The sides of all piles shall be removed, so that the thickness of the piles measured on a line parallel to the center line of the shut-off dam shall be not more than 14 ins.

For the purpose of payment, the round piles in the shut-off dam shall be divided into two classes:

Class A shall include round piles in place in the shut-off dam, 45 ft. or less in length.

Class B shall include round piles in place in the shut-off dam over 45 ft. in length.

The lumber in the shut-off dam, except as otherwise shown on the plans, shall be of long leaf yellow pine, unless otherwise directed by the Chief Engineer, "Merchantable" inspection according to the rules of the Georgia Interstate Saw Mill Association, 1904. The sheet piles shall be not less than 10 ins. in width. The splines shall be 1½ ins. by 3 ins., and not less than 10 ft. long, except that in the gates each spline shall be in one place for the full width of the gate. The splines shall be fastened with 6-in. nails driven not more than 2 ft. apart. The grooves shall be uniform and of such size that they will fit the splines. Care must be taken to have a straight and even surface on the top of the sheet piling, to make a close joint with the gates, and the bottom of the gates shall be carefully fitted to the top of the sheet piling.

All lumber in the shut-off dam, not specified above, shall be spruce of the best quality, sound, full size, free from unsound, loose and hollow knots, worm and knot holes and shakes.

The dimensions of the wrought-iron and steel and cast-iron and steel in the shut-off dam shall be as shown on the plans or as directed. The material and workmanship shall be of good quality and satisfactory.

Long leaf hard pine and spruce piles of larger diameter than specified were used.

Short leaf hard pine of larger dimensions than called for by the plans was used for bracing in parts of the dam; the upper planks in the gates were also short leaf pine.

The contract prices and cost per foot of dam were as shown in the table at the bottom of the page.

Test piles were driven along the center line of the shut-off dam, previous to beginning work thereon for the purpose of determining what the piles in the dam would have to withstand by reason of hard driving and to develop possible obstructions.

An unusually high tide occurred in Boston Harbor in December, 1909. The Charles River Basin Commission in their annual report for 1909 have the following to say regarding this high tide:

The highest tide which was of record at the time the dam was built, that being the tide of April 16, 1851 (Elev. 115.67), which, with the storm accompanying it, destroyed the Minot's Ledge lighthouse (April 17); and on Christmas morning, 1909, a tide almost exactly the same height as the Minot's Ledge tide was recorded on the gages which the Commission has caused to be kept at various points. This tide then reached the height of 115.59 ft. Had this tide not been kept out of Charles River it would have flooded not only all the basements along Beacon Street and Bay State Road, but a large portion of the Back Bay and the South End. There would have been nearly 5 ft. of water above the surface of Church Street near Park Square. It is estimated that in one day the Dam thus saved in damage to public and private property a sum equal to a considerable portion of its cost.

The Charles River Basin Commission went out of existence by limitation on June 30, 1910, at which time the dam and basin was turned over to the Metropolitan Park Commission, to operate and maintain.

The original Basin Commission consisted of Dr. Henry S. Pritchett, Chairman; Henry D. Yerxa and Joshua B. Holden. Dr. Pritchett resigned Jan. 1, 1908; Mr. Yerxa became chairman and Edgar R. Champlin was appointed to fill the vacancy.

Mr. Holden did not live to see the completion of the work in which he had taken so great an interest during the seven years of its development and construction; he died June 23, 1910, after a lingering illness.

Hiram A. Miller, M. Am. Soc. C. E., was Chief Engineer; John L. Howard, M. Am. Soc. C. E., Principal Assistant Engineer, and the writer, Division Engineer in charge of the work at the dam and lock, the Cambridge marginal conduit, and the dredging in the Cambridge canals and basin. Walter E. Wheeler was the Assistant Engineer in charge of the construction of the shut-off dam. The men who did the most to make successful the construction and final closure of the dam were Samuel Taylor, Inspector, and Fred Logan, Foreman Carpenter for the contractor.

The contractor for the dam, lock and sluices was the Holbrook, Cabot & Rollins Corp., of Boston, Mass.

GENERAL VIEW OF THE BOSTON END OF THE CHARLES RIVER DAM AFTER COMPLETION.

CONTRACT PRICES PER FOOT.

Item.	Price.	Quantities per ft.	Amount.	Total qualities.
Lin. ft. round piles, Class A	$0.24	32.08	$7.91	21,002 lin. ft.
M. ft. B. M. spruce	0.30	20.19	6.06	13,223.5 lin. ft.
Lbs. wrought iron and steel	60.00	0.4401	26.41	290,663.75 ft. BM
Lin. ft. round piles, Class B	46.00	0.111	5.11	72,587.7 ft. BM
M. ft. B. M. long leaf, HP	0.06	92.83	5.57	60,803.9 lbs.
Cost per lin. ft.			$51.06	

Total length, 656 ft. Total cost, $33,500.00

The Aziscohos Dam, Rangeley Lake Region, Maine.*

By SETH A. MOULTON.†

The new reservoir which will be created by the construction of the Aziscohos Dam will be a unit in the comprehensive system of water storage which has been developed at the head waters of the Androscoggin River.

The present reservoir system comprises the natural lakes and ponds in that section of northwestern Maine commonly known as the Rangeley Lake region; including Rangeley Lake proper, Kennebago, Cupsuptuc, Mooselucmaguntic, Mollychunkamunk, Welokennebacook and Umbagog Lakes, together with several small ponds at the head waters of tributary streams.

The discharge from these lakes is controlled by substantial, rock-filled log crib dams constructed about 32 years ago at the outlets of Rangeley, Mooselucmeguntic, Welokennebacook and Umbagog Lakes. The water impounded by these dams being utilized to increase the low water flow of the Androscoggin River for the benefit of the various mills that obtain water pawer from the Union Water Power Co.'s canals in Lewiston, Maine.

The rapid growth of manufacturing on the Androscoggin River, simultaneous with the development of the falls, between the outlet of the lakes and the City of Lewiston, combined with the additional demand for water power in Lewiston and at other points on the river, has made the present storage supply inadequate for furnishing the required low water stream flow.

For the past seven years, Mr. Walter H. Sawyer, the Agent and Engineer of the Union Water Power Co., has been constantly studying the storage problem, ultimately reaching the conclusion that it was entirely feasible, and of immense value to all water-power users on the Androscoggin River, to create a new lake at the head waters of the Magalloway River, a tributary stream discharging into Umbagog Lake. To form this new lake it was necessary to construct a new dam at the head of Aziscohos Falls, near the site of an existing crib dam which had been constructed by lumbermen, and was used for logging purposes only.

The present reservoir system has storage capacity for about 17,000,000,000 cu. ft. of water and the new basin a capacity of about 8,000,000,000 cu. ft., or an additional supply equal to practically 50% of that now available. The value of the increased storage is best defined by stating that the Aziscohos Lake will furnish a volume of water sufficient to operate all the mills in the City of Lewiston for a period of 72 days, without supply from any other source.

Owing to the prolonged delay in the selection of the type of dam, it was considered impossible to prepare sufficient detailed plans and specifications, from which satisfactory contractors' bids might be obtained, in season to proceed with the work during the year 1910. On account of this condition, the company instructed the engineering firm of Sawyer & Moulton to proceed with the work on the "force account" basis, with orders to commence at once to accumulate the necessary apparatus and supplies for its execution.

This decision was reached on Feb. 15, 1910, allowing, under the most favorable weather conditions, a period of only eight weeks in which to collect and deliver to the dam site a 1,200-ft. span, five-ton cableway, hoisting engines, derrick fittings, sluicing pumps, concrete mixers, stone crushers and such other heterogeneous materials as are ordinarily required for work of this description.

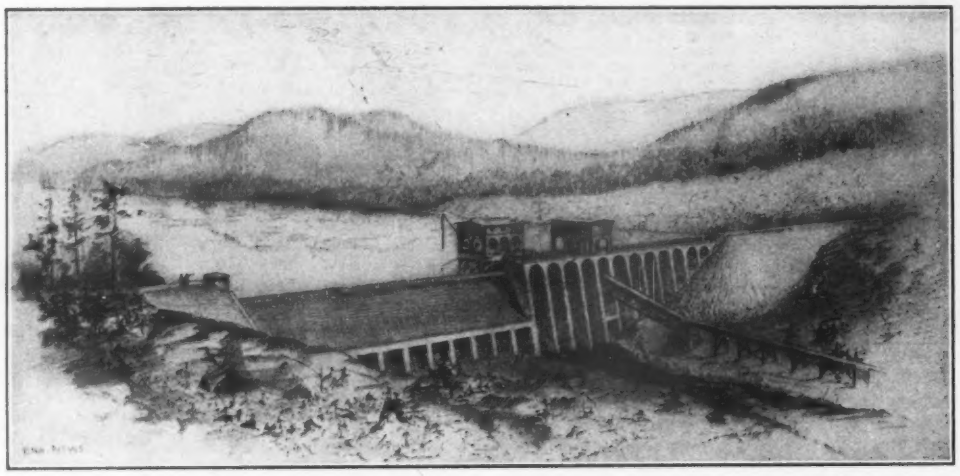


FIG. 1. SKETCH SHOWING THE AZISCOHOS STORAGE DAM, RANGELEY LAKES, MAINE.
(Concrete, with buttresses spanned by arched deck.)

The task seemed almost impossible, involving, as it did, the purchasing and transporting of 250 tons of material within so short a time limit. Fortunately, success attended the attempt to obtain and deliver the necessary outfit; although at one time the situation seemed dubious, owing to the fact that an early thaw set in before the cableway was delivered at the railroad terminal, at which time the snow had practically disappeared from a portion of the highway and beyond this section a streak of slush and mud indicated where the road should have been. The cable was started on wheels, but met with disaster when transported but a few miles; and from thereon brute force alone accomplished the dragging of the cable on an improvised timber sled through the mud, to the dam. The cable was a piece of apparatus absolutely essential to the efficient conduct of the work, accordingly no expense was spared in the endeavor to deliver the same, and after three weeks of gruelling effort, with the aid of twenty horses, it was successfully landed at its destination.

The engineers were confronted with the problem of economically constructing a work of first magnitude in a wild and undeveloped country, with the contingent difficulty of maintaining a large community remote from its base of supplies, but throughout operations the construction work has proceeded smoothly, without delay, other than that occasioned by natural conditions; in consequence, since the commencement of the concreting on July 13, 1910, an average of 100 cu. yds. per day has been placed; a very satisfactory accomplishment considering the character of the design.

Transportation.

The remote location of the dam made it apparent that the most difficult problem to be solved would be that of transportation. The work is situated about 38 miles from the nearest available railroad station at Colebrook, N. H., the intervening highway being of the ordinary country type; which, owing to adverse climatic conditions, is practically impassable during from six to eight weeks in the ordinary spring season, or from about April 1st to the middle or last of May, and it is useless to attempt to haul a load of any magnitude during this period. Even during the most advantageous summer weather sections of the roads are in poor condition for heavy teaming due to the nature of the road material and the effect on same of the frequent showers combined with almost continuously cloudy weather.

During the first two months of the ordinary winter season "toting" can be carried on more advantageously than at any other time; but after the first six to eight weeks sledding, the fall of snow becomes so great that it is very difficult to keep the teams on the built-up trodden section of the roadway unless special precaution is taken to provide proper turnouts and to keep the surface of the hard road well below the level of the surrounding snow.

It was obvious that whatever type of dam was adopted it would be necessary to haul material at least during one winter and one summer season, and possibly during two winter seasons. The "toting" situation necessitated that the volume of material to be hauled should be carefully predetermined in order that it might be delivered in anticipation of the needs of the work.

Serious consideration was given the advisability of employing traction engines with trailer sleds for winter toting and motor trucks for summer toting; but after an exhaustive study of the conditions it was decided to haul the materials with "tote" teams, the method of transportation common to this section of the country.

The country passed through being very sparsely settled, it was with difficulty that provision was made for sufficient accommodations at the intermediate stopping points, and carefully prepared time-tables were established, to which, barring accidents, the teamsters were compelled to adhere. Neglect to obey the Toting Superintendent's orders regarding stopping points was considered sufficient reason for the discharge of the offending teamster, unless ample proof could be furnished for the necessity of disobedience.

All material was hauled by the hundred-weight and each operator was held responsible for the material in his custody from the time same was delivered to him at the railroad station until deposited in the company's store-houses at the dam site. A comprehensive system of triplicate way-billing and checking was devised whereby exact but simple records were kept of the material hauled at both the Colebrook and the dam store-houses, one way-bill being retained by the teamster as a voucher.

The round trip of 76 miles from Colebrook to the dam and return is made in four days, each team making two complete round trips without rest and laying off the ninth day.

Four, five and six-horse teams were employed, averaging 4½ horses to a team, and by a proper arrangement of the time schedule a maximum total of 180 horses could be accommodated on the road, making a total of 40 teams, which, on the basis of four days to a trip, gave an average of ten teams arriving at the dam during each day of the toting season.

During the best period of toting, or for the six weeks from Dec. 1 to Jan. 15, the average loads were as follows:

Four-horse team	6,650 lbs.
Five-horse team	8,600 lbs.
Six-horse team	10,400 lbs.

the average load per horse being 1,680 lbs.

During the best period of summer toting:

Four-horse team	5,750 lbs.
Five-horse team	none working
Six-horse team	8,400 lbs.

the average load per horse being 1,430 lbs.

During the most adverse condition of toting:

Four-horse team	4,800 lbs.
Five-horse team	6,200 lbs.
Six-horse team	7,200 lbs.

the average load per horse being 1,220 lbs., or 20% less than could be hauled during the best sledding.

The total average load hauled per horse being 1,460 lbs. for which the toting contractors received 65 cts. per hundred-weight, as a flat rate for all seasons, making $2.11 the average earnings per horse per day. The average cost to the company for materials delivered to the dam is 85 cts. per hundred-weight, the additional 20 cts. per hundred-weight being due to overhead charges, including the cost of superintendence, bookkeeping and store-house expenses.

The preliminary investigation of the toting problem indicated that the maximum volume of material which could be transported during a winter sledding season would not exceed 5,000 bbls. of cement or a gross weight of two million pounds; if the usual methods of procedure in vogue prior to this time were employed. This amount was so obviously insufficient, even for the preliminary stages of the work, that special effort was made to overcome each interfering detail in order that a maximum tonnage might be moved during the first season.

Consultations were held with teamsters and toting contractors, who had devoted their entire lives to hauling supplies into the woods for the lumbermen, and no encouragement was obtained from these sources as to the probability or possibility of exceeding the previously stipulated quantity of 5,000 bbls. of cement, or its equivalent of 2,000,000 lbs. In spite of the discouraging prospect, the situation was carefully analyzed and a system of operation adopted which has had no material change since its inception.

The prime factor limiting the quantity of the material which can be transported is the topographical condition of the country over which the road is constructed. The highway passes over a divide in the Dixville Mountains at a distance of about 12 miles from Colebrook and this portion of the road has a constant up-hill grade, necessitating much lighter loading of the teams than would be otherwise essential, as the road between Dixville Notch and the dam is comparatively level. To obviate this condition an intermediate store-house was erected beyond the height of land in the Dixville Notch to which relay teams hauled materials from Colebrook. This arrangement permits the through teams to start with small loads, increasing same at the Dixville store-house to the full capacity of the equipment, if the roads beyond are favorable.

A second intermediate store-house was provided at Errol, N. H., about 20 miles from Colebrook to which relay teams delivered materials. This provision permits the hauling of maximum loads from Errol to the dam even in the event of bad roads between the Dixville store-house and the above-mentioned village, a likely condition owing to the exposed situation of this region.

That the system was successful is shown by the results of the first season's toting, for from Dec. 1, 1909, to Feb. 10, 1910, a period of 72 days, 11,000 bbls of cement, together with other miscellaneous supplies amounting, in total, to 4,500,000 lbs., were delivered to the dam site, more than 100% in excess of the prophesied quantities. From the commencement of the toting on

*Portion of Paper presented at Annual Convention of the National Association of Cement Users, New York City, Dec. 12-17, 1910.

†Member of firm, Sawyer & Moulton, Consulting & Designing Engineers, Portland, Me.

Dec. 1, 1909, until Nov. 1, 1910, a period of 335 days, the total amount conveyed, as shown by the teamsters' records, was 7,250,000 lbs.

The consideration of the above-mentioned facts reveals the obvious need of a design requiring a minimum weight of toted materials.

Design.

The reconnoissance surveys and preliminary borings made during the summer of 1908 indicated that the best location for the dam would be at a point in the river valley about 250 ft. below an old crib structure.

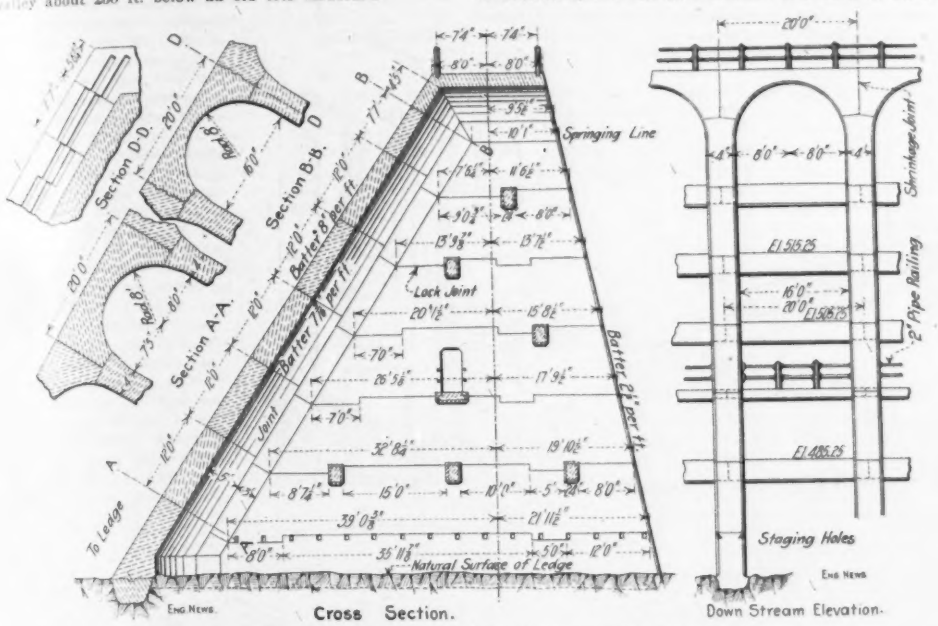


FIG. 2. DETAILS OF MAIN DAM SECTION, AZISCOHOS DAM.

The conditions controling the selection of a proper design for the dam places this work in a class peculiar to itself, for in addition to the limitations imposed by the transportation problem, the logging situation presents structural difficulties rarely, if ever, before encountered in constructing a storage dam.

In Fig. 1 is shown a sketch of the dam as it will appear when completed.' No claim is made that the elemental scheme of the adopted type is original as the idea has been closely paralleled by several projected prototypes; although to our knowledge none of these have been carried to completion. The structure contemplated for the "Pioneer Power Plant," described in Transactions Am. Soc. C. E., v. 38, has a very similar cross-section.

The selection of the cellular construction was made after careful consideration of all the conditions involved, its final acceptance being based on the fact that it contained a minimum of material with maximum stability, an essential property for this particular dam; but the writer wishes to record at this time the general statement that in his opinion with less adverse conditions of transportation, and of auxiliary complications, no economical reason can be offered for its adoption. Certainly the engineering duties are much more arduous and taxing than they would be for a design of more simple composition.

The general dimensions of the dam are as follows:

Total length from end to end of core walls	881 ft.
Maximum height from crest of main dam to ledge foundation	78 ft.
Length of main dam	265 ft.
Length of spillway	236 ft.
Height from surface of water in river to level of water surface at full lake	60 ft.
Crest of main dam above full lake level	7 ft.
Top of embankment above full lake level	12 ft.
Maximum high water above full lake level	6 ft.
Depth of draft from reservoir	47 ft.

Fig. 2 shows a typical cross-section of the main dam taken centrally between buttresses. This portion of the structure consists of 14 4-ft. thick buttresses spaced 20 ft. c. to c. The top of the buttresses being approximately 13 ft. 6 ins. wide with slopes on the upstream and downstream faces, respectively, of 7 9/16 ins. and 2½ ins. per ft. of height, these proportions being found ample to ensure the stability of the structure, with conservative unit pressures in the buttresses. Arched slabs spanning between the piers form the deck and crest, the intrados of the arches having a radius of 8 ft. It will be noticed that the first 3 ft. of the intrados of the arch ring are cast on a bevel instead of circular, and integral with the buttresses. This was done to simplify the form construction. It will also be seen by reference to Fig. 2 that the haunches of the arches are cast with solid spandrels, making the water face of the dam a smooth slope with a batter from the vertical of 8 ins. per ft. The crown thickness of the arch slabs at the crest of the dam is 2 ft. and at the lowest point approximately 4 ft.

Particular attention is called to the shrinkage joints provided over the center of each buttress, and the locks in these joints, between the abutting spandrels, which are incorporated to prevent seepage; these locks being staggered at the various vertical stopping points.

Rectangular reinforced-concrete struts, or beams, are provided between the buttresses to insure lateral stability.

A typical cross-section of the spillway is shown on Fig. 3. The spacing of buttresses, the upstream profile of buttresses, and the deck slab for this work is identical with the main dam construction. A mass of cyclopean masonry is provided for the spillway crest to resist ice pressure, and an overflow apron is constructed on the downstream face to deflect the water from the buttress bases. Owing to the existence of the crest and apron the stiffener beams employed between the main dam buttresses are omitted between the spillway piers.

All of the arched slabs are reinforced with corrugated steel bars, sufficient metal being used to prevent cracks at the crown of the arches and to concentrate the effect of temperature and shrinkage stresses at the spandrel joints.

The deck slabs for the spillway were completed in August and have consequently been finished about four months, a period sufficient to develop the greater part of the shrinkage deformation, during which time there has occurred a temperature change of 90° F. Apparently the shrinkage reinforcement has successfully accomplished the desired results, for all of the completed joints have opened equally about 1/16-in. throughout their entire height on the upstream face of the dam; these cracks diminishing from the face until they become invisible at the arch springing lines on the buttresses.

The heavy spillway crest is reinforced with channel beams, provided more especially to support the forms and heavy weight of the concrete during construction. The overflow apron is reinforced by sufficient steel to withstand the impact due to a maximum freshet overflow.

The different grades or mixtures of concrete used in the several portions of the structure are designated as classes A, B, C, D, E, F, G and H, with proportionate parts as follows:

	Cement.	Sand.	Stone.
A	1	2	4
B	1	2½	5
C	1	3	6
D	1	4	7
E	1	2½	5 with spalls
F	1	3	6 with spalls
G	1	2½	5 cyclopean
H	1	3	6 cyclopean

The varying aggregate dimensions for the above were defined by exponent figures in connection with the class letters; for example: "A-¾" indicates a 1:2:4-composition having a graduated crushed stone aggregate, with sizes varying from the fine material rejected by a ¼-in. dust screen up to and including the fragments that pass the perforations of a ¾-in. diameter screen. The use of stone dust was permitted by considering same as sand, and reducing the amount of sand proportionately.

The class "A" concrete is employed in the construction of the gate and logway buildings, and for those portions of the structure that require slender cross-sections of maximum strength. The arch deck slabs and all concrete placed below water level are composed of class B, E or G concrete, the two latter grades being used in situations where the cross-sections will admit the interspersion of hand or derrick placed, thoroughly clean, stone.

Above water level the buttresses are constructed of class C, F or H concrete, the permissible grade depending on the area and shape of the cross-sections. Class D concrete is only used for heavy mass work of minor importance, where bulk alone is needed.

The southerly end of the main dam is embedded in an earth embankment with a reinforced-concrete diaphragm, or core wall, extending from the last buttress into the solid material of the natural bank a sufficient distance to insure a practically impervious cut-off. This construction was adopted on account of the extreme depth of the ledge at this point.

It was originally intended to place the embankments by the hydraulic sluicing process, and apparatus was obtained for the purpose; but the exceedingly hard formation of the borrow pit material made it uneconomical to employ this method, on account of the expense contingent on pumping a large quantity of water under high pressure with very low efficiency of earth displacement.

Test pits indicated that after the hard surface soil had been penetrated, water-bearing subsoil would be encountered; accordingly provision was made for driving steel sheet piling under the south core wall for a considerable distance from the main dam buttress, but this was found to be unnecessary.

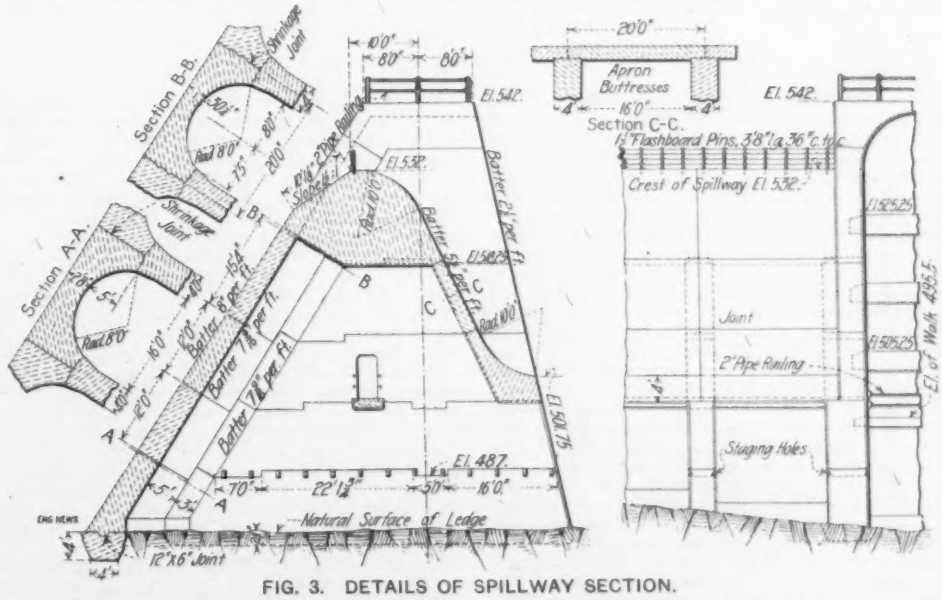


FIG. 3. DETAILS OF SPILLWAY SECTION.

Logging.

Mention has been previously made of the logging contingency but for a full appreciation of its effect on the work a brief description of the problem is essential, in order that the adopted methods for solving this difficulty may be understood.

The entire drainage area appurtenant to the Aziscohos Lake is heavily wooded and will undoubtedly be for all time a timber-growing country, owing to its location and mountainous character.

Investigation of the lumbering situation revealed the fact, that, without question, an average of 20,000,000 ft. of logs (board measure) will be sluiced annually from the lake during the next 20 years. The river below the proposed dam has a fall of 200 ft. in a distance of two miles, a condition necessitating the flow of a large volume of water to float the logs over the falls and rapids; and for supplying this "sluicing head" the existing dam was built.

Records of the water discharged from the old dam during the "sluicing season," show that under the most favorable existing conditions 137,000,000 cu. ft. of water are required for each million of logs passed through the dam, with an average annual total of 2,740 million cu. ft., or more than 25% of the entire storage capacity of the lake. By improving the river channel with wing dams, that will restrict the width of the waterways at abrupt pitches, it will be possible to reduce the average total quantity of water required for sluicing to 1,000,000,000 cu. ft. per annum. Ultimately still greater economy of water for log driving will be obtained by constructing a V-shaped flume, or log chute, from the dam to the foot of the rapids, when the average total water required will be reduced to 250,000 cu. ft. per annum.

The total annual average run-off from the water shed is about 10,596,000 cu. ft., or roughly 30% more than the 8,000,000,000 cu. ft. essential for filling the lake; but study of the run-off records indicates that the lake will not be filled every year, also that the lake will be at its lowest level during the latter part of March, and will, in ordinary seasons, obtain most of its supply from melting snow in the spring. The log-driving season commences as soon as the ice leaves the lake, an event several weeks in advance of the thaws that melt the snow and ice in the woods.

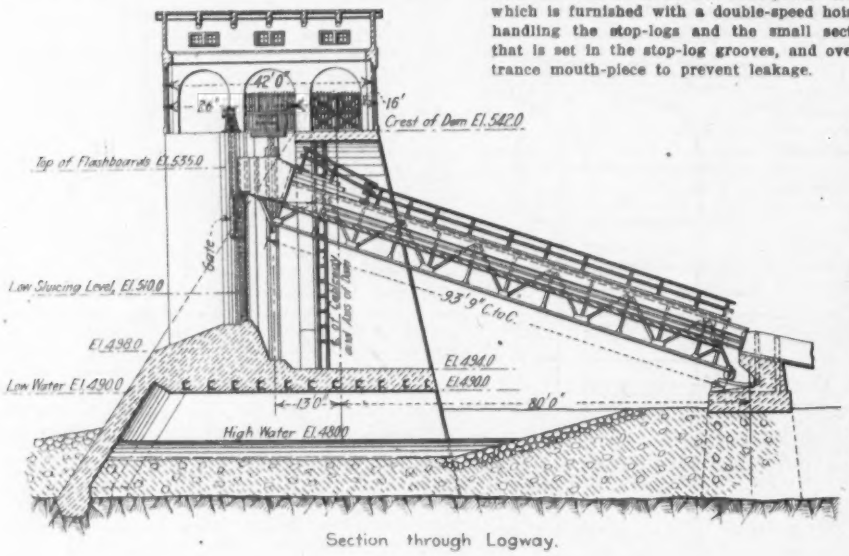
Consideration of the above facts makes it apparent that provision must be made for sluicing the logs through the dam at varying stages of lake level.

Thorough study was made of the run-off in relation to the sluicing requirements, resulting in the conclusion that it would be necessary to design a logway which could be utilized at any lake level between elevation 510 and the crest of the flash boards at elevation 535, or for a range of 25 ft.

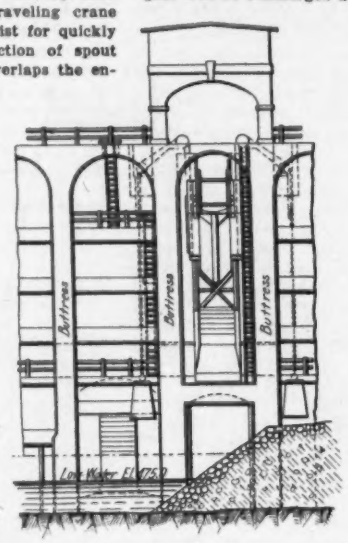
General views of the perfected arrangement for the log sluice, and its accessories, together with the adjacent low-head waste gate, which will be used to drain the lake and possibly as an emergency log sluiceway, are shown on Figs. 4-6.

The essential features of the logway are: a vertical slot cut out of the arched face slab between two of the buttresses for a depth of 38 ft. below the crest of the main dam, the adjacent buttresses being of sufficient increased thickness to make the clear opening of this slot 7 ft. wide; a movable steel truss, having a clear span of 93 ft. 9 ins. c. to c., supporting a V-shaped flume; and an inclined fixed section of V-shaped spout, or flume, continuing from the end of the truss to a downstream point convenient for discharging the logs into the river.

The raising and lowering of the truss is accomplished with the aid of a 15-ton hand-power traveling crane which is furnished with a double-speed hoist for quickly handling the stop-logs and the small section of spout that is set in the stop-log grooves, and overlaps the entrance mouth-piece to prevent leakage.



Section through Logway.



Down Stream Elevation.

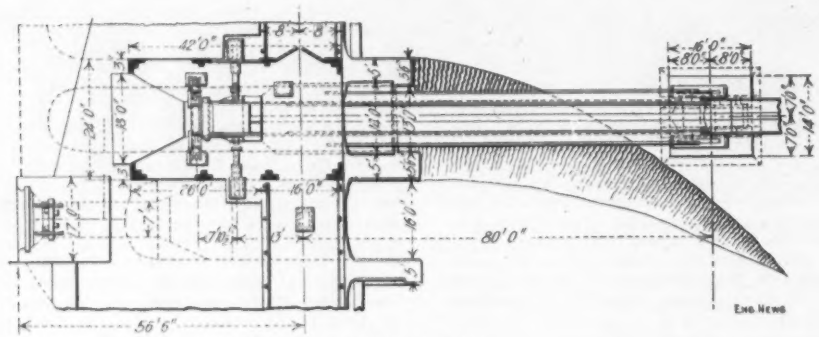
The swinging truss is suspended at the upstream and between a gallows frame, riding on bronze sliding strips, which bear against the planed surfaces of cast-iron guides set in the sides of the concrete buttresses. The truss bearings rotate on a trunnion shaft which is attached to the gallows. A rectangular steel mouth-piece is rigidly fastened to the gallows frame, providing an entrance to the log sluice always at right angles to the stop-logs, with a minimum clearance from same.

On top of the gallows frame headers, a working platform is secured, from which the attending lumberman guides the approaching logs, or manipulates the locking mechanism when changing the position of the sluice. A special system of automatic locks, seating in notches provided in the gallows guide castings, has been devised, whereby the truss always rests on rigid supports, unless the lifting hook is securely fixed in its proper position, thus precluding the possibility of releasing the load from the crane until the truss is safely anchored in the desired position. Chains from the gallows frame are passed over idlers into the adjacent bays of the dam, supporting concrete counterweights which neutralize, to a large extent, the dead load of the truss, relieving the crane proportionately. (See Fig. 5.)

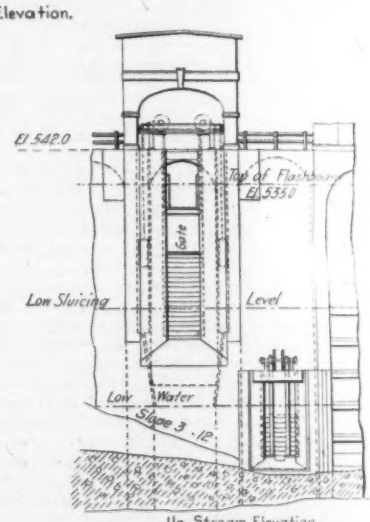
The downstream end of the truss is supported on trucks that travel on T-rail tracks having curved profiles of proper shape to maintain a minimum clearance between the overhanging section of steel flume, which protrudes from the truss, and the section of fixed flume that rests on a concrete abutment, designed to resist the shock due to the impact of the rapidly descending logs. The base receiving the end of the truss and the end of the fixed spout consists of a substantial concrete pier founded on bed rock. A heavy cast-iron wearing plate is imbedded at the entrance of the fixed spout in the concrete abutment to prevent excessive wear anticipated at this point, owing to an abrupt change in the grade of the flume.

The logway opening is closed with 12 × 16-in. yellow pine stop-logs bearing in cast-iron grooves, situated at the end of the taper approach formed by the converging faces of the concrete abutments. The stop-log c[illegible]gs are embedded flush with the buttress masonry, a[illegible] are designed to act as guides for a gravity drop gate [illegible]ch travels in front of the upstream face of the sto[illegible]gs. This gate is composed of a structural steel fram[illegible]n-cased in concrete, and is suspended on counterwe[illegible]ed chains, controlled by means of a hand-operated [illegible]t located on the floor of the logway house. When [illegible]e log sluice is operating at the highest levels the [illegible]p gate will be submerged a small distance below the t[illegible]t the stop-logs ready for [illegible]e instantaneous closure of [illegible]e logway in the event o[illegible]n accident in the flume. At the lower stages of slu[illegible]g the gate will be susp[illegible]ed a proper distance abov[illegible]e water level, and will [illegible]e in a position permitting expeditious control. The ga[illegible] is made of sufficient height to close the logway with bottom submerged 2 ft. below the top of the stop-logs when they are removed for the full depth of the flume entrance, providing a screen to protect the operator when removing or placing the stop-logs.

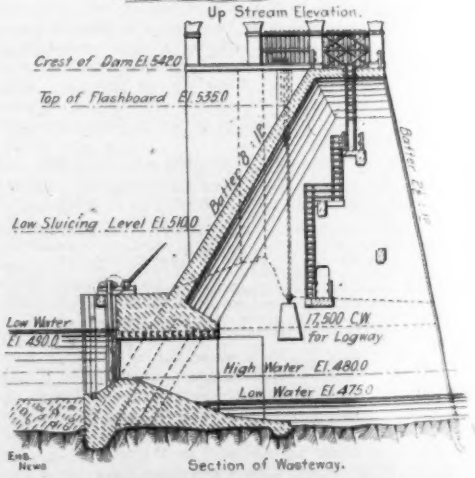
A space of 6 ins. is left between the upstream face of the stop-logs and the downstream face of the drop-gate. A timber bolted to the bottom of the drop-gate closes this space sufficiently to create a pool of quiet water between the stop-logs and the gate, which eliminated the spurting streams that would otherwise occur, seriously handicapping the manipulation of the stop-logs, if this water cushion was not provided.



Sectional Plan.



Up Stream Elevation.



Section of Wasteway.

FIG. 4. LOGWAY AND WASTEWAY OF AZISCOHOS DAM.

Before deciding upon the design for the logway a series of experiments were conducted with large-scale working models, and experienced river drivers called upon to criticise the various schemes, strongly advocated the adopted apparatus, claiming that its capacity would be limited only by the quantity of logs which could be delivered to the entrance, a feature always the controlling factor regulating the capacity of a logway. Conservative estimates show that at the higher sluicing

level, under favorable conditions, 3,000,000 ft. of logs, board measure, may be easily sluiced in ten hours, and that the minimum capacity of the outfit will be not less than 1,000,000 ft. of logs in ten hours.

The maximum velocity of the logs at the junction of the movable and fixed flume will be, approximately, 2,000 ft. per min., and the minimum velocity 1,000 ft. per min. The swinging spout, which is the elemental feature of this design, is simply an amplification of similar timber structures that have been erected to accomplish the same purpose, under smaller variations of head, by the ingenious Yankee lumbermen of northern Maine, and is only noteworthy on account of its exceptional proportions.

Construction.

The preparatory work of clearing site, building roads, cutting timber for fuel and saw logs and the erection of temporary buildings, preliminary to the actual construction, was commenced on Sept. 1, 1909. The selected form of dam was not determined upon until February, 1910, consequently the tasks accomplished during the winter of 1909 and 1910 were necessarily confined to the execution of such general work as would be required for the erection of any type of structure, and comprised the construction of cement sheds, temporary log sluice, bunk-houses and sawmill; also the hauling of cement, lumbering operations and the digging of test pits to determine the location and character of the foundation rock.

Estimates were prepared in the engineers' office showing the probable time limits essential to complete the various sections of the work; compiled from the evidence of test pit data and based upon diagram sketches of the several stages of operation. The test pits indicated that the over-laying ledge cover was a very refractory material composed almost entirely of compacted, impalpable, rock flour deposited by glaciers. The test pits, in conjunction with a meager number of borings, indicated that the ledge was a very coarse granite formation of medium hardness, providing a foundation entirely suitable for sustaining the contemplated loads.

To complete the work in the season of 1910, the progress estimates showed that the concrete plant equipment must be ready for operation, and the spillway excavation be completed, ready for placing concrete, about the first of June. These desired results were attained.

While excavating the ledge trenches, for the buttress footings and the cut-off wall at the base of the upstream face of deck slabs, suspicious and disconcerting seams were encountered, after the first two or three feet of the hard granite surface rock had been removed. These seams appeared to consistently exist at all points excavated and it was realized that the situation was serious. Accordingly immediate steps were taken to determine the extent of the stratification with the ultimate result that it became essential to excavate from 8 to 16 ft. of the surface rock before the laminated formation was sufficiently removed to insure an unyielding foundation. The ledge seams were from ½-in. to 12 ins. deep and were filled with rock flour, intermingled with an occasional layer of disintegrated granite.

The faulty condition of the ledge necessarily upset all time calculations, and precluded the possibility of commencing the concrete work on the first of June as anticipated. This unfortunate predicament seriously handicapped the whole work and delayed the placing of any concrete until July 13. A peculiar circumstance in connection with this incident is the fact that the preliminary shot drill borings, although admittedly insufficient, gave no indication that there existed any very soft material, except in one instance where a large clay pocket was encountered; but this was on the south side of the stream under the deep natural bank and was attributed to a local fault. The only explanation which can be offered for the above inaccurate representation is that the shot drill was too small, making it impossible to remove a whole core of any great length, thus deceiving the operators and making them accept the short cores as a result of the apparatus limitations.

Forms are always an element of first importance in concrete construction, for they have material effect on both cost and progress, and should, accordingly, be subjected to as careful consideration as any other detail of the design.

Realizing the truth of the above assertion, and also appreciating the fact that the proposed dam consisted of a series of duplicate parts, it was apparent that a system of interchangable forms, in standard unit sections, would be not only feasible, but would economically expedite the work, if they were properly constructed. Accordingly complete plans were prepared for the principal form work of the buttresses, arched slabs and core walls, also for forms having special conditions of loading or that were structurally complex.

The writer does not intend to convey the idea that sectional forms are materially, if any, cheaper per unit of contact surface than the ordinary kind built in place; but their use is strongly advocated on account of the rapidity with which they can be assembled ready for the placing of concrete, without employing an army of carpenters to keep the form work ahead of the concreters. It is undoubtedly true that the unfortunate foundation difficulties encountered in this instance had material effect on the unit cost of the forms on account of the concentration and consequent congestion which it occasioned. Had it been possible to spread out the work over a sufficient number of piers, a much more creditable showing could have been made; as matters stand, the forms have accomplished a saving of from 150,000 to 200,000 ft., board measure, of lumber, and have been instrumental in effectively increasing the quantity of concrete placed; the average since commencement being 100 cu. yds. daily.

To reduce, as much as possible, the opening of the shrinkage joints between the face slabs, the bays are cast in alternate sections. To obtain maximum benefit from the initial shrinkage of the concrete a time interval, as long as possible, is allowed to elapse before pouring the concrete in the intermediate bays.

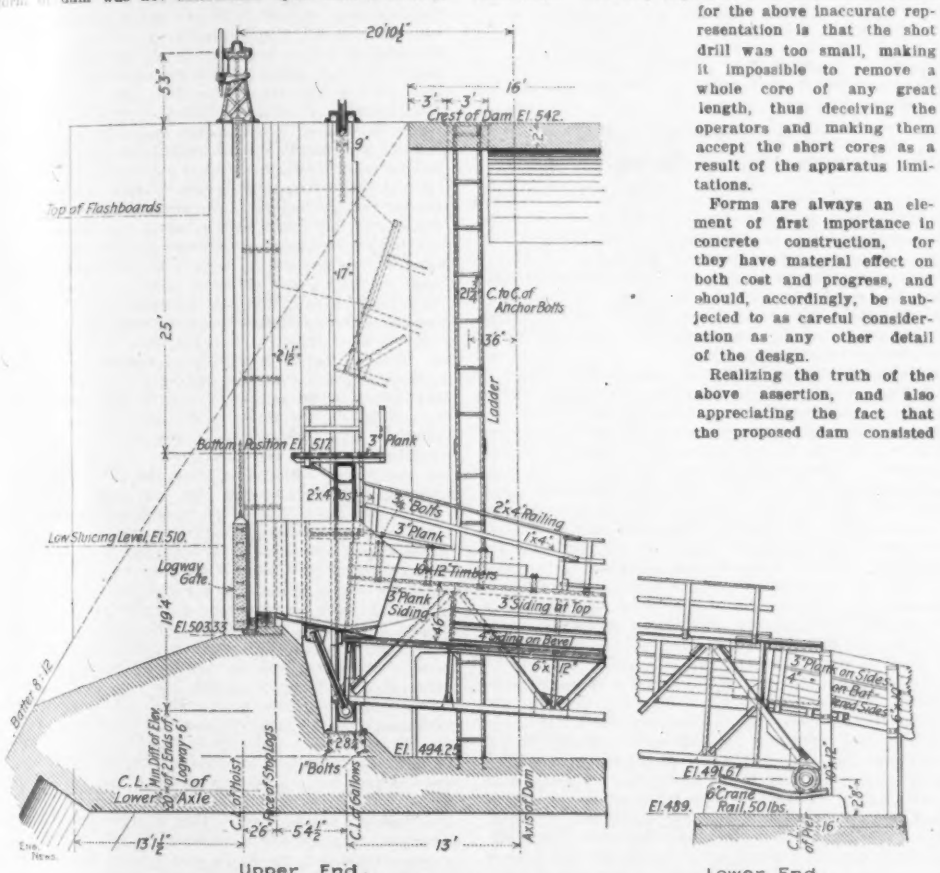


FIG. 5. DETAILS OF UPPER AND LOWER ENDS OF LOGWAY.

THE HONESTY OF CONTRACTORS and a specific case of peculiar engineering ethics were discussed by Mr. C. A. P. Turner, M. Am. Soc. C. E., in a recent address before the Canadian National Association of Builders' Exchanges. In commenting upon the occasionally accepted idea that all contractors, and especially all concrete contractors, will take every opportunity to skimp work, Mr. Turner said:

The speaker's business is to a large extent that of consulting expert for a large number of general contractors and builders. By constant dealing with them he has learned to appreciate their integrity and their desire to do work which will be creditable to their reputation as constructors. They have learned the lesson that a good reputation as a builder is a most valuable asset commercially, and that they cannot afford to lose this reputation by failure to make good. They have learned it to be a fact that the larger profit in the line of construction is secured by scientific and systematic management of the work; by looking sharply after the purchasing, seeing that the materials are delivered when they are needed to push forward the work, and suitable equipment is supplied and on the ground for the economic execution of the work, and that everything is carried on in an orderly and systematic manner, planned and laid out in advance. By so doing, the cost of executing the work may be kept down to a minimum.

These men, in paying the bill for the cost of construction, are inclined to check up rigidly their ideas of theoretical economy with cold figures as to what the work has actually cost. They pay the bill, and in doing so, the results secured, guide them in their judgment.

We might compare this class of men with some of those who pose as concrete experts in the engineering profession to-day. While I will not accuse these men of technical dishonesty, their business methods savor somewhat of the faker.

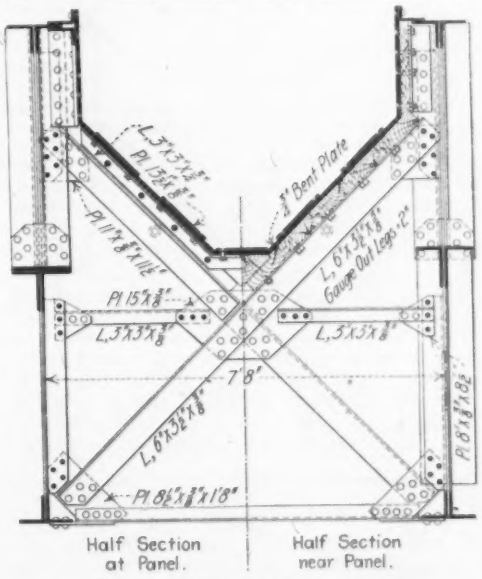


Fig. 6. Cross-Section of Logway.

About three years ago, a prominent structural bridge engineer in the United States, a man who has earned considerable reputation in the line of steel bridge work, delivered a lecture in one of our state universities and, when asked about concrete as a structural material, stated to the boys that he was not familiar with what concrete men were doing in this line, but he did not think it amounted to very much. Since that time he has seen a great light. He has suddenly concluded that there was money in the concrete business, and after the six day consideration which it probably took to arrive at this conclusion, he came out as a full-fledged concrete expert.

One of his early pieces of work in a large Pacific Coast city was a report as expert on a reinforced-concrete viaduct. Now this particular viaduct had been tested by the contractor with five times its working load on the sidewalk and five times its working load over a full panel of the roadway and it had stood this test without injury and without indication of weakness. The design of this viaduct did not apparently harmonize with the peculiar theoretical notions of this expert without experience. Accordingly he directed that the viaduct be strengthened. What it would carry, or might be tested to, cut no figure with his theories. The concrete was drilled into and additional rods added with the net result that, figuratively speaking, he had cut the liver out of the concrete and added a considerable amount of steel, and undoubtedly reduced the resulting strength of the structure from 10 to 25% at an expenditure of approximately $40,000. When it comes up for trial as to who is to pay this expenditure, the contractor or the city, unless this expert is able to hypnotize the judge into believing that his theoretical notions as to the strength of the structure are more reliable than the determination of its actual strength by the law of gravitation in applying the actual test, then we may be certain that the taxpayers in that city will have a large bill to pay for the absurd recommendations of this so-called expert. It is fair to point out that this so-called expert, with practically no experience in the line of concrete worth mentioning, has earned deservedly a high place in the American Society of Civil Engineers by his work in the field of steel construction, but work in this line does not qualify an engineer to assume the role which he has assumed in the line of concrete construction.

A Novel System of Concrete Reinforcement.

A novel system of reinforcing concrete, which has been extensively used in South America, has recently been patented in this country and is now being applied to several structures here. It is known as the "Lewen" system, after its inventor, Mr. Henry L. Lewen, of New York City.

The fundamental detail of the system is a peculiarly shaped corrugated sheet of steel which forms the reinforcing element of the construction, but which at the same time serves as a form within which to place the concrete, thus avoiding the use of wooden or metallic forms which have to be removed after the concrete has taken its set. Fig. 1 shows the original application to the system to the construction of poles or piles and illustrates the general design, which in a modified form, is applied to various other types of structures. In the construction of these poles the corrugated plates are bent around in the circle as shown, and tied together by a double line of wire passed over and through perforations punched into the projecting ribs of the plates, with the wires looping one through the other as shown on the large size detail in Fig. 2. This forms a rigid framework secure against the expansive force of the wet concrete which is afterward placed inside and later serving as reinforcement to resist both the direct compressive stresses to the loading of the pole or pile and the tensile stresses which may result from eccentric loading. The framework is then set up vertically and filled with concrete. The finish coat is given to the outside by plastering mortar of the required consistency or mix to the outer face of the plates, the corrugations in which afford a very effective bonding surface.

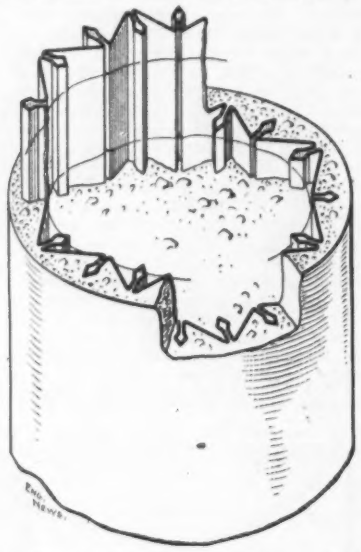


Fig. 1. The Application of the Lewen System of Reinforcing Concrete to Poles or Piles.

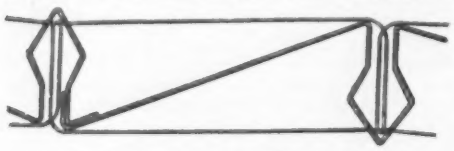


Fig. 2. Detail of the Corrugated Plate Tied Together With Wire.

This is the elemental type of pole. Modifications include the use of a weak interior concrete where great strength is not desired or the use of an inner removable form when a hollow pole is desired. In general use the sheets are from No. 14 to No. 30 gage, with the corrugations from 1½ to 2½ ins. deep, about 1¼ ins. deep, and spaced from 3 to 6 ins. apart. The size and spacing of the wire depends largely upon the stresses to be resisted.

A further application is to building construction where walls, floor-slabs and columns are built according to the system, though the slabs are supported on steel or concrete beams, tied into the columns by a special detail. In this construction the columns are made substantially as are the piles shown here, only they are cast in place, but the corrugated reinforcement for the walls and slabs is not tied together by the wire. Slabs may be cast either in place or on the beams and are of concrete reinforced near the bottom with the corrugated plates. The outer walls are of hollow construction, each part being reinforced with a corrugated plate, the hollow being formed by a removable form, or else a type of plate is used in which the corrugations are all on one side. With this latter type the flat face of the plate forms the inner face of each part of the hollow wall, and the corrugations project into the concrete forming the wall. These walls may, too, be cast either in place or on the ground. For partitions only one line of corrugated plate is used, and the concrete is plastered to each side.

It will be noticed that the main point of novelty in the design is the use of the interlocked wire to give the necessary strength and rigidity to the corrugated plates during the placing of the concrete.

The Premium Plan of Paying for Labor.*

By CLINTON ALVORD.†

In the past, labor has been paid for by two methods, commonly known as "day work" and "piece work." The employer always thinks of articles as costing so much per piece, no matter what the style of payment has been, while the workman figures his pay as so much a day. He might receive 2 cts. each for drilling certain holes, but he is interested in the total sum received for his day's work.

A man working by the day receives no direct share of any gain he may make by extra diligence. If his average is ten pieces per day, but on some especially brisk-feeling day he produces twelve pieces, the extra production goes entirely to the employer, so the workman's only incentive to increase his output is the hope of future increase of daily wage. He is satisfied to keep busy and give a fair day's work. When working by the piece, all the gain goes to the workman except the gain of the employer due to the greater output of his factory under the nearly constant office-expense or burden.

Under the day-work plan the employer finds fault with the foreman for the undue cost of things and strives, by pressure of scolding and stirring up of pride, to increase the output. The high cost leads to the adoption of piece work, and the foreman is told he must make articles for a stated price in the future. Here comes in the first compulsion. Under piece work the employer waits until the workman who has been earning $12 per week by day work has climbed up to, say $16.50 per week, and then cuts the price. If the employee refuses to undertake the work at the new price, somebody will; if he keeps on at the new price he learns the lesson his employer has taught him, and now knows his pay limit. Would he not be foolish to exert himself sufficiently under the new price to get up to the old $16.50 per week again? Let me give an illustration. A well-known manufacturer was discussing cost systems with the writer. His plan was piece work with continual cuts. He claimed the men loafed, never did within 30% of what they could; and to prove it told the following incident: A workman had been with him for some five years, and as his work had been on one line most of the time they had his production within close limits. The price had been cut several times on this work. He left for some reason and a new man was put in his place. The first day the stranger increased the output almost 15%, and the second day it went up to 25%; however, the third day this production dropped to the figures of the first man and stayed there. I remarked that his shopmates had told him he was simply working for a cut in price and our manufacturer admitted such was probably the case. The writer tried to show that the men had been well educated, and had learned their lesson, but my friend could not see it and claimed they were simply loafing.

The incident just mentioned shows that the "piece work" plan, as an instrument for decreasing cost, tends to defeat the object after the first one or two cuts. It is in appearance a system of rewards in which the man who works the hardest gets the best returns, but the cuts will come, and a cut is a punishment for doing well. The lazy man on piece work is not cut; it is the energetic worker making the large production who is punished. The good man finds he must work harder after a cut to get the same pay; and is there a reader of this article who would keep up the pace for daily increase with the knowledge that cuts were coming? The piece work and cut system results in greater output and less cost than under day work, but the spirit of progress is checked. The workmen push their earnings as near the cut limit as they dare and then stop making further effort.

About eight years ago I was talking with an intelligent American workman who had been on the same work for over 15 years. He was turning cast-iron pieces at a speed of 24 ft. per minute using mushet steel. The writer described the new high-speed steels and argued for a speed of at least 50 ft. per minute as the iron was soft, and the chip light. Finally my friend said, "Well, Mr. Alvord, I have been cut three times in the past 15 years and what is the good of getting it again? I guess that speed is good enough for me."

A number of years ago a friend of mine worked for a Water Meter Co. A certain part of the meter was given him as piece work, and he pushed the production, and consequently his wages, until a cut came. He accepted the cut, rigged up some better holders and again advanced the production, and wages, only to receive a second cut. My friend used his brain and produced some new formed tools so that sizes would be maintained without the continued use of calipers and scale, and a third time the production advanced. But, is it strange he learned his lesson? When the foreman was away or busy he pushed the production up, and after hiding a portion of the finished product under the pile of rough parts near his machine, turned in a suitable number finished. He knew the danger line and was careful to keep on the safe side to avoid a cut. The parts that were hidden were brought out from day to day, and turned in to help swell the pay envelope at a time when he had been working entirely at day work.

I give these instances to show the real leading and teaching of the piece work plan. Is there one of my readers who has not heard of or seen similar cases?

Prices of most things decrease in the long run, and a manufacturer cannot pay his workman a higher wage than his competitors pay. If his men are working piece work the cuts must come, in the endeavor to lower cost. Under day work the employer gets all the gain of increased production; under piece work the workman gets the immediate gain. The premium plan splits the difference between these two. Mr. F. A. Halsey of New York City was the originator of the plan. Suppose a piece of work has been done by day work and it is proposed to change it to the premium plan. The workman is paid his old rate, and is told that if he will reduce the time taken by day work he will receive in addition to his daily wages a premium for all time saved on the job over the time taken by day work; this premium per hour being less than his hourly wage. This is where the division comes in. If he objects to trying to reduce the time, he is told, "Very well, try or not as you think best—there is the work and the offer, and the premium is ready whenever you have earned it." As a rule there is something wrong if the workman does not cut the time limit by one-third.

At the start the individual workmen are opposed to the plan. They have been fooled so often by piece work that they expect this is a similar scheme, and that the cuts will be coming. After they learn the workings of the system they often ask for it faster than the management can arrange to give it out. The hope of an increase in dollars from extra diligence must be experienced before one can appreciate the driving force it exerts.

The plan works as follows: A workman is paid, say, $3 a day and produces one piece of a kind a day, of ten hours. He is told that he will continue to be paid $3 a day as before but that if he will reduce the time on the piece he will be paid in addition to his wages a premium of 10 cts. for each hour saved. If he reduces the time an hour that hour represents in money value a gross saving of 30 cts. Ten cents of this amount is paid to him as a premium, leaving 20 cts. in the employer's possession. You see the man's wages go up, and the cost of work goes down.

The table at the bottom of the page will show this.

When the piece of work has been done in five hours the wages cost has been reduced one-third, and the man's hourly wages increased one-third. Could anything be fairer to both parties? The employer makes an additional gain due to the increased production of his

*Reprinted from an article in the "Journal of the Worcester Polytechnic Institute" for January, 1911. A paper read before the International Engineering Congress at Glasgow, Scotland, in 1901 and reprinted in Engineering News of Sept. 19, of that year, described in some detail the premium plan as then in use in Great Britain. A description of the Premium Plan by Mr. F. A. Halsey, its originator, was printed in our volume for July-December, 1891, p. 61.

†President, Worcester Loom Co., Worcester, Mass.

1 Time consumed, Hours	2 Wages per piece, Dollars	3 Premium, Dollars	4 Total labor cost of work, col. 2 col. 3, Dollars	5 Workman's earnings pr. hr., col. 4 col. 1, Dollars	6 Burden 16c. per hr., Dollars	7 Total cost, Dollars	8 % Saved total cost, Dollars
10	3.00	0.	3.00	0.30	1.60	4.60	0.
8	2.40	.20	2.60	.325	1.28	4.88	12.6
5	1.50	.50	2.00	.40	.80	2.80	39.12

plant, but this is not a part of the premium plan, for the same saving would come by piece work.

It is similar to profit sharing, the difference being that the workman receives his profit at the end of the week instead of waiting until the end of the year; and nobody can understand the impetus given to one's work by the knowledge that extra money is to come from increased effort until it has been given a personal trial.

The premium plan is very simple, but it has been introduced slowly in the United States although England has taken to it favorably. The rate of premium is the first thing to be determined, if the plan is to be introduced. Pay what is necessary to get what is wanted, but pay no more. We must offer an inducement large enough to encourage the workman to gain it. If the time limit is too low, he will not try for it; if too high, you are throwing away money. Never cut the time limit unless the system of doing the work is changed.

If a piece of work has been done on a boring mill with one tool, and a new and improved double-tool boring mill is installed, the time should be changed, but care should be taken to allow the workman to make more money on the new machine than the old. To cut the time, or rate, is to kill the goose that lays the golden egg. The plan does not prevent rate cutting, but it makes it unnecessary and unprofitable.

What shall be the premium rate? Some shops divide the wage; others give 40% or 30%. A simpler plan is to give a flat rate per hour—8 cts. per hour is one-third of $2.40 per day. The writer adopted 7 cts. per hour, and finds the men call for premium work on new parts upon which the time limit must be fixed without a knowledge of the day-work time. Some hard headed manufacturer will say that he pays his men to work as hard as they can; his foreman is hired to see that they do so; if they don't do their full duty, then get rid of them, and get a foreman who can drive the men. According to his idea the premium plan is giving the men a present for former laziness.

Do men work as hard as they can when working for a wage? Won't a man work harder for himself than for some other man? Won't he work harder if a goodly sum is the result than he will if the return is but meager? Experience proves that a generous time limit will produce better results than one set too close. There are various methods for arriving at the premium earned. A Mr. Rowan, of Glasgow, Scotland, who builds and installs marine engines and employs some 350 hands, has entered thoroughly into the system, and was one of the first to use it in Great Britain. At one time he claimed to be the original inventor of the scheme. Mr. Rowan gives as a premium a percentage of the reduction. The objection to all the percentage systems is the fact, that the men find trouble in figuring their earnings, and must therefore take the word of the timekeeper. Many men find trouble in figuring 30% of 27½ cts., and this would be the case of any man earning $2.75 a day and receiving a regular 30% of the time saved. A $1.65 man would certainly have trouble. A flat rate is easily figured, and any workman can keep track of the money earned.

Some one may think to himself that it shows up the superintendent and owners pretty well, when a time limit is set and a workman cuts a large slice off the time. Some of my readers are saying to themselves that they would never set a time limit that a workman could divide by three. Maybe not, but try it and brag afterwards. The premium system certainly shows up the office, for the man who is working on "premium" has the hope of gain before him to stimulate his brain, attention and energy, just as a man in business for himself is spurred on to greater forethought and more careful planning by the expectation of gain. It hurts the pride of many a foreman and superintendent who thinks he knows all about the time required to do certain jobs, when the workmen cut the time. For an illustration: A friend of mine, a tool maker, recently paid me a visit on a Saturday afternoon. A workman was doing a job of drilling and counter-boring. A hub had cored bosses with holes for six arms, and he must drill and ream the holes 1¾-in., and counterbore the ends of the bosses. My friend looked the job all over and gave his opinion, that two hours was good, rapid time in which to do the job. That would be 20 different operations at 6.5 minutes each. The first time the work occupied 2 hours and 24 minutes each when four hubs were run through, so our friend was close to the mark. The first premium time was 54 minutes and the time when my friend saw the work done it dropped to 46 minutes, and since then it has been lowered to 39 minutes when eight hubs were run through.

Good men do better work with premium than with day work for the mind is concentrated on the thing being done, and there is less chance of error. There are, however, certain jobs that had better be done by day work than any other way, provided there is no good system of inspection. The straightening of cold-rolled shafting is one of these, for it is a job easily slighted.

If the men work in gangs the reduction in time is not nearly so marked. Each man appears to be afraid he may work a little harder than his mates, and he knows the extra time must be divided among the rest. Premimum work in gangs is good, but the gain is not so pronounced as in individual work.

The unions have not taken kindly to the premium plan. The union speaker, who recently answered President Eliot, asserted that the unions never limit the amount of work a man can do in a day. But, the increase of output appears to be the only fault the unions can find with the premium plan. In England some of the unions have accepted premium work; but I believe that all unions oppose it in this country.

It is amusing to hear the remarks when the premium plan is first started. The men think there is a "must" in the time limit, and it takes much explanation to show that nothing will happen (except a poor record in the cost department) if they fall behind. The first time we put a gear blank for a 120-tooth 6-pitch gear on premium, the workman almost threw up the job. He was told he need pay no attention to the premium card, but just take his regular gait, and if he earned anything it would come to him. Finally, with much grumbling, he began the work, but he informed the foreman most forcibly that no man living could come within the time limit. The talk had taken up a portion of the time, but there were 12 blanks, and after the fifth one was finished our all-knowing workman began to whistle for he found that he was ahead of the game, We have changed men several times on that turret machine, and a new man always objects vigorously over the time allowed on that gear blank. The foreman brings out the record card to prove his statements, and finally if the castings are good and soft the new man will make a new record.

The objection brought forward by the workmen shows clearly that as a general thing the men have no clear idea of the time required to do a given piece of work.

When the writer insisted that a certain shaft could be finished, exclusive of the cutting off and centering, in ten hours, there was war in the camp at once. The foreman argued that possibly it could be done in 12 hours, and we used a time limit of 13 hours so as to encourage the workman. The first man tackling the job wanted 20 hours, and the talk of 10 hours made him throw up his job. The first premium time was 9½ hours; it then dropped by degrees to 7½ hours, and by encouragement to 6½ hours which was a record for several months. The writer does not claim anything original in the foregoing description of the premium plan, but he did consider that it was new for the foreman to share in the premium. However, I find that there is a large machine-tool concern in Cincinnati that does the same thing. Well, my foreman became disgusted when the time on such shafts went back to 8 and 8½ hours, and by broader cuts, the last four shafts were reduced in time to 6 and then to 5½ hours. Nobody knows the shortest time in which we can do the work with our facility. The shaft is made of 4-in. diameter soft steel, is 7 ft. 3⅝ ins. long, and weighs 326 lbs. in the rough, and there are four micrometer fits. We remove 98 lbs. of metal.

The teeth of a 24-tooth, six-pitch miter gear can be cut on a milling machine in 33 minutes when working premium and in lots of 20 or more. Our day-work time was 1 hour and 10 minutes. Good, soft castings and premium have enabled us to decrease the time of cutting teeth down to 48, 37, 36, 35, and 33 minutes. Each of the 24 teeth must be cut twice and you can understand the young man must do some hustling to put on the blank, make 24 cuts, shift over his machine, make 24 more cuts, and remove the finished gear in 33 minutes.

The foreman can help the system along in a substantial manner and therefore it pays to enlist his help by giving him a sum equal to a stated percentage of the earnings of his men. He can grind their tools, get up new and improved tools, and help in many ways. I give the foreman a sum equal to 25% of what his men make.

It pays the management of a manufacturing plant to install the premium plan. I have heard a cost department called a "costly department." Call it what you will, it is something a plant cannot afford to be without. If one already has a cost department, then the premium system will add but a slight expense.

An examination of the preceding table will show the total gain if an article is produced in one-half the old time. I have assumed a burden of 16 cts. an hour. This burden is figured as actual office or general expense for each productive hour. If a shop has 10,000 productive hours in a month, and the rents, salaries, taxes, supplies, etc., total to $1,600 for the month, then each productive hour will carry a burden of 16 cts. to enable the shop just to meet expenses.

Column No. 6 shows the saving made in burden, and column No. 7 illustrates the total saving of wages and burden. By decreasing the time taken to perform one piece of work from 10 hours to 5 hours, column No. 7 shows that the combined wages and burden cost has dropped from $4.60 to $2.80 or a decline of 39%. If two competitors were each doing this piece of work in 10 hours "day work," and one of them by premium system reduced the time to 5 hours, then his "day work" competitor would be paying 64% more for labor and burden cost than he was.

When a small number of pieces are to be run through, and the time for setting-up the machine represents a substantial item in the total hours taken, it is a simple matter to allow 20 or 30 minutes for the setting-up and thus secure this work being done on premium. It may be well to state that boys with small pay should have a lower flat rate than should men. We have three rates i. e., 7 cts. for the men, 4½ cts. for the young fellows and 3½ cts. for the boys. Always talk hours and minutes to the men and never talk dollars and cents, except that of course they must know what the flat rate is for each hour saved.

With piece work there is always an unpleasant argument when a cut is made. The premium plan entirely avoids this, for the workman cuts the labor cost each time he reduces the hours and improves the record. He continually tries to improve the record and thus swell the contents of his envelope at the end of the week, and each increase that comes to him decreases the labor cost of the piece. Thus the laborer is satisfied and so is the shop management. Nobody knows the shortest time in which it is possible for some workman to do a given job, and each employee is constantly striving to lessen the time taken.

The Interstate Commerce Commission's Decision Upon the Proposed Advance of Railway Freight Rates.

[Concluded from p. 276 of issue of March 2, 1911.]

Should Railway Rates be High Enough to Permit Permanent Improvements to be made Out of Surplus Earnings?

It is contended by the defendants (and this is one of the most important questions before us) that rates should be sufficient to enable them not only to pay their current operating expenses, their fixed charges, a reasonable dividend, and to maintain their properties at the present state of efficiency, but also to make improvements and additions to those properties of a permanent character. Those who oppose an increase in these rates answer that improvements of this character which add to the permanent value of the property ought not to be paid from the current returns of the railroad, but should rather be made out of new capital, and they point to the previous decisions of this Commission and to the approval of those decisions by the Supreme Court of the United States as confirming that position.

Both the court and the Commission are committed to the proposition that in fixing a fair return upon railroad property for the purpose of determining whether a given advance is reasonable, the railway ought not to treat as a part of its operating expenses the cost of permanent improvements or extensions. This must of necessity mean that the rates should not be sufficient to allow both the payment of dividends to stockholders and interest to bondholders and an additional sum for the purpose of improving and increasing the value of the property. Theoretically, this would seem to be just. Each generation may well be required to bear its own burden, and the stockholders should not obtain both an adequate dividend upon his stock and an addition to the value of his property.

It is urged, however, that in the public interest this Commission, for the purpose of preventing the excessive capitalization of our railroads, ought to adopt a different policy. Within certain limits it may be the right of this Commission to consider this question as one of public policy and not one of strict legal right. If the true interest of the whole community requires it, we should perhaps allow these railroads sufficient earnings with which to add to their properties in addition to the payment of a return to their stockholders, even though there is no strict requirement of law which commands it. What, then, are the reasons which have been urged by the carriers for the adoption of this view at this time?

It is contended, first, that our railroads can not raise the necessary funds with which to make improvements and extensions and that therefore they should be allowed to impose rates which will provide these funds. It is said that most of our railway systems are covered by a general underlying mortgage; that whatever improvements are made become, when made, subject to the lien of that mortgage; and that it is therefore impossible to secure in any adequate way this advance of new money.

This argument does not appeal to us. We doubt the practical difficulty suggested, and, were it true, it is not apparent that the general public should stand responsible for the mistakes which have been made in financing these railroad systems. As previously observed, it would be much better for the Government to directly guarantee the bond or loan the money than to permit a general schedule of unreasonable rates for the purpose of taking care of particular instances of this nature.

It is strenuously insisted that railroads are being required to expend large sums in certain classes of improvements which do not add to the revenue-earning capacity of the property. Instances are the erection of expensive passenger stations in large terminals, like the one here in Washington, the abolition of grade crossings, the elevation of tracks through towns and cities, the adoption of safety appliances, etc. There is a pub-

lic demand for these improvements which often takes the form of a legislative enactment or a municipal ordinance, and it is insisted that the public which demands should expect to pay for the improvement.

By way of illustration, let us take the elevation of tracks. Years ago, when the railway was constructed, there were no buildings along its line, but in process of time a town has grown up, streets cross the track at frequent intervals, and the municipality requires that the tracks be raised, and this is done at a very considerable outlay. Now, the railroads urge that this improvement does not add to the earning capacity of the road. It may save a trifle in the way of gatemen at crossings, and may somewhat reduce the casualties for which the railroad is liable, but, on the whole, it is an expenditure which adds nothing to the net income of the railway.

But just how is that a reason why this improvement should be paid for out of present earnings? Why should the shippers of to-day pay for the elevation of these tracks? The improvement will continue and redound to the benefit of the public as long as the railroad lasts. If a new railroad were to be built where that one is the tracks would be elevated. Assuming that a proper allowance has been made between the difference of constructing the railroad at grade originally and subsequently elevating the tracks, the cost of the road is precisely the same as it would be were it a newly constructed railroad upon that location. In other words, where lies the difference between a revenue-producing and a nonrevenue-producing improvement? So long as the improvement is for the future the present must not be entirely taxed to provide it. The elevation of those tracks has added to the cost of the railroad; the value of the property which that company is using for the public benefit has been enhanced, and this justifies it in demanding from the public a greater return than formerly, but not in demanding the price of the improvement itself.

If the Accumulation of this Surplus be Permitted, Would the Public Have Any Claim Upon It?

While this would seem to be the law of the situation, there is a suggestion of public policy which might under some conditions lead to a different conclusion. It is a wise thing for a nation as well as for an individual to lay up something for the future. This nation in time to come must engage in active commercial competition with the rest of the world. We must manufacture and sell against other nations. Railway rates will enter as an important factor into that competition. Not only the rate upon the raw material to the factory and upon everything which enters into the cost of living will be of consequence, but also the rate from the factory to the port. Germany and France to-day use their railroads to assist the home manufacturer as against his foreign competitor by allowing a special rate upon articles for export.

In the past we have enjoyed cheap raw materials. Our food has been cheap; our coal and our ores have been near the surface; our lumber has been plentiful. These resources are being exhausted; the cost of food is increasing; our forests are being depleted. We must go deeper for our coal. All this will render the cost of production more expensive, and it might be wise to lay up in our railroads a fund which should be of assistance to future generations in offsetting this tendency to increase the price, were there any assurance that the fund when provided could be made available. There is the gravest doubt upon this point, for the reason that whatever is invested in these properties from earnings may belong, not to the public which has paid for it, but to the stockholders who have already received a full return upon their investment in the way of a dividend.

The President of the Pennsylvania Co. testified that since 1887 his company had put into the Pennsylvania lines east of Pittsburg $262,000,000 from earnings. During all that time this company has also paid to its stockholders munificent dividends. Now, to whom belongs this $262,000,000, a sum which, according to the statistical report of the Pennsylvania Railroad Co. to this Commission for the year ending June 30, 1910, equals nearly two-thirds of the total cost of construction of the 2,123 miles owned by that company?

Suppose this Commission were required to fix a value upon the Pennsylvania lines east of Pittsburg. Could any distinction be made between this sum which has accrued from the operation of the property and what has been paid in from other sources?

What the claim of the railroads will be when the matter finally comes to an issue is well shown by a question which was asked upon the argument and answered by that attorney who was urging most strongly the right of the railroad to accumulate a surplus for this purpose:

> Question. The popular idea seems to be that these properties ought to be physically valued, and that the rate should be determined by the value of the property so fixed. In that case, would the surplus be entitled to be appraised as a part of the value?
>
> Answer. As of the date that such a valuation takes place, the property as it stands belongs to the stockholders. That has been in accordance with the policy of the Government, and it would take a change in the policy of the Government to change that legal situation. So I think the valuation would necessarily be on the property as it stands.

The carriers in the proceeding now before us have claimed that they should be allowed to invest in improvements and additions to the property an amount equal to that paid by way of dividends to stockholders. In the year 1910 railroad dividends aggregated $405,131,650. If this sum were to be invested in our railways annually for the next half century it would amount at the expiration of that period to $20,256,582,500, not regarding the item of interest. This sum is far in excess of the present total capitalization of our railroads. It is not improbable that it may equal the total amount which will be expended in railway development in the next half century, and upon this vast amount which has been accumulated in addition to a fair return upon the investment railway stockholders will claim a return. Every dollar which has thus been added to the value of these properties justifies, according to the claim of these defendants, an added net return, and it is further claimed that the Constitution of the United States protects these defendants in the right to impose such charges as will yield this return.

It is evident that until the status of this surplus is determined by legislative action or judicial interpretation, this Commission can not properly permit an advance in rates with the intent to permit an accumulation of surplus for this purpose.

Other Arguments for the Surplus Fund.

It is also said that railroads should be allowed to accumulate a surplus for the purpose of providing, for the time being, for the interest charge on new capital, which represents an improvement which is necessary, and which will finally be profitable, but which does not pay an immediate return.

To this claim within certain limits we assent. In the development of a railroad it must often invest money in permanent structures like a passenger station which will not add for the time being to its revenues, although it may do so finally. It is reasonable to say that such rates may be charged as will permit the accumulation of a fund to take care of cases of this sort. But to this surplus fund stockholders should be required to contribute by reasonable reduction in dividends. If such a system of financing is to be adopted as will render the payment of dividends upon common stock as certain as those upon preferred stock, then the dividend to the holder of the common stock should be no larger.

It is further urged that there is an item of obsolescence in the development of a railroad which should be recognized in the surplus. New methods demand new facilities. Changed conditions require changes in construction. That which was right at the outset becomes valueless and must be replaced in process of time.

If the accounts of a railway are kept according to the present requirements of the Commission the cost of construction as shown by its books can contain no factor of obsolescence, for when a thing goes out of service the value of that thing must be written off. This has not been uniformly true of construction accounts in the past.

Under our present system of accounting railways are required to make a depreciation charge with respect to their equipment for the purpose of providing against contingencies of this sort; but they make no such charge with respect to their way and structures, and it seems proper that the accumulation of a surplus should be allowed in this view.

Then, too, a railroad must be allowed to accumulate a surplus in good years which will offset bad years, and if its financial position is to be a reasonably strong one that surplus must be large enough to remove doubt from the mind of the investing public. We think that a railroad in ordinary years should be permitted to show a substantial surplus over and above the payment of a reasonable dividend. This is necessary to provide for interest on capital invested in improvements which will not yield an immediate return, to take care of the element of obsolescence, and to tide over years of depression.

The Reason Why a Decision on Rates for One Road Must Apply to All.

The rates advanced are mainly class and commodity rates applying between the East and the West, and it is well understood that of these rates the Chicago-New York rate furnishes the base. Official Classification territory west of Buffalo and Pittsburg is divided into groups which take a percentage of the Chicago rate, so that an advance of the rate between New York and Chicago automatically works an advance in all this territory. Since the present relation of rates must be maintained, and since the same rate must be made by all lines, it follows that if any single route be required to maintain the present scale between New York and Chicago no advance by any line can be made.

The question, therefore, arises, and is one of very great difficulty and importance. What line shall we examine for the purpose of determining whether its net revenues may properly be increased? The Delaware, Lackawanna & Western carries a considerable amount of this traffic from New York to Buffalo and it may be carried from there to Chicago under joint tariffs now in effect by the Lake Shore & Michigan Southern. The cost of the Delaware, Lackawanna & Western, as shown by its statistical return for the year 1910, is $147,880 per single-track mile. Its operating income for the same year was $16,641 per mile, as against $9,581 per mile in 1901. Its corporate income for the year amounted to 49.77% upon its outstanding capital stock, having increased to that figure from 16.6% in 1901. The price of its capital stock on December 31, 1901, was $258 per share, as compared with $[illegible] on December 7, 1910, which was the date of the latest sale. Plainly, this road is suffering from no financial strait which would justify an increase in these rates owing to the increase in wages.

The Lake Shore & Michigan Southern Ry., whose financial condition will be considered more in detail later, makes almost as favorable a showing. In the year 1910 that company paid its fixed charges, a dividend of 18% upon its capital stock, and had remaining over $5,000,000 surplus for the year.

It is plain that if these two roads were to be considered alone no justification could be found from a revenue standpoint for these advances, and that is the question before us. On the other hand, there are lines operating in this territory where the showing in favor of the advance, having reference to their financial necessities, would be a strong one. What lines, then, shall be examined for the purpose of reaching a conclusion in this matter?

The Pennsylvania lines extend from New York, Philadelphia, and Baltimore to Chicago and St. Louis and reach most of the important cities west of Buffalo and Pittsburg by their own rails. In the year 1900 the earnings of that system were more than one-quarter of the aggregate earnings of all the 41 railroads previously named. This Commission might very well say that it would make the Pennsylvania system the standard by which to measure the reasonableness of these rates. On the whole, however, it seems fairer to include with the Pennsylvania the New York Central lines upon the north and the Baltimore & Ohio upon the south. Under rates reasonable for these three systems, there may be lines whose earnings will be extravagant, but that is their good fortune. There may be lines which cannot make sufficient earnings, but that is their misfortune. We ought not to impose upon this territory, for the purpose of allowing these defendants additional revenues, higher rates than are adequate to these three systems considered as a whole.

Increasing Volume of Traffic and Its Effect on Operating Costs.

Viewing the freight rates of this country as a whole, it will be found that rates are usually the lowest in those sections where the traffic is most dense. It has been frequently said by railroad witnesses that this ought to be so because the freight rate should decrease as the density of traffic increases. Stated in the most general terms, the reasons are these:

The cost of constructing a railroad which will handle economically traffic producing $5,000 per mile of gross revenue is substantially the same as though $10,000 per mile in traffic were handled. The grading, the ties, the embankments, the stations, would all be practically identical. The cost of maintaining this road is not much greater under the larger volume of tonnage than with the smaller. About the same number of men are required and about the same amount of material.

Certain elements of cost in the operation of the road are the same whether the traffic be at the higher or the lower figure, as, for instance, the stationmen, the telegraph force, the signalmen, etc.

In recent years very great economies have been introduced into the handling of traffic upon most of our railroads. Curves have been eliminated and grades reduced; larger cars and stronger engines are employed. An engineer and a trainman handle more tons per mile to-day than 15 years ago; a ton of coal hauls more tons of freight one mile to-day than in 1896.

Under the larger volume of business the car loading and the train loading each lends itself more readily to economical operation.

It has been noted that in the 14 years from 1896 to 1909, inclusive, the tonnage of our railroads increased more than 100%. This, acting in the manner above indicated, tended largely to increase the net revenues of the railways. Not only did these causes tend to produce a lower cost of operation per unit, but the number of units was more than doubled. This makes very strongly for a reduction in the freight rate.

Influences Tending to Increase Operating Expenses.

Upon the other hand, there are a set of influences which work in exactly the opposite direction. Comparing 1896 with the present year, nearly all kinds of supplies which enter into the construction, maintenance, and operation of a railroad have very much increased in

price. Nearly one-half the cost of operation is labor, and it is said that within that period the wages of railroad employees have advanced 30%. We are told that not only has the price of a day's labor increased, but that the efficiency of that labor for various reasons has decreased. Legislative enactment, both of the Federal and of the State Governments, has in the interest of the public and the employees required the employment of additional labor. Laws like the employers' liability act will add to the damages which railroads must pay for injuries to their employees.

The public is demanding a better and a safer railroad, and this finds expression in the requirement for the abolition of grade crossings, the elevation of tracks, the use of safety appliances, the installation of block signals, the substitution of steel cars for wood cars, and in a great variety of other ways.

The economies just referred to, like the reduction of grades and the use of larger equipment, have necessitated large outlays of capital, and upon this an additional return must be earned.

Taxes have increased and are increasing more rapidly than the value of the property.

All these influences tend strongly toward higher freight rates, for they not only add to the cost of operation, but they increase the cost of the plant, upon which a return must be made.

The action of these contending influences is extremely complex and the result can not be affirmed with certainty except from actual experience. This matter was considered by the Commission In re Southwestern Rate Advance Case, 11 I. C. C. Rep., 238, where we reached the conclusion that, although wages had increased, a dollar invested in labor moved a ton of freight farther than under a lower wage scale. Our general conclusion in that case was that, on the whole, increases in supplies and labor had not increased the operating cost per unit in the territory covered by that investigation.

This was in 1904. There is nothing in the record before us from which we can conclude with any certainty whether since then the cost per unit has increased or decreased. The carriers insist that it has increased. Including taxes as a part of the expense of operation, gross operating revenues have increased by a much larger per cent than operating income in case of nearly all these defendants. Looking to the Baltimore & Ohio, the Pennsylvania Railroad, and the New York Central & Hudson River, we find that in every case the percentage of operating expenses to operating revenues was greater in 1910 than in 1904 and greater than the average for the seven years.

This would tend to show that the cost per unit had increased, since the average receipts per ton-mile upon these lines have remained fairly constant. Upon the other hand, the Pennsylvania Railroad Co. distinguishes in its accounts between the cost of transacting its freight and passenger business and states to its stockholders from year to year the cost per ton-mile of handling its freight traffic. According to these reports, the cost to that company for the calendar year ending December 31, 1909, was lower than for any other year in its whole history, with the exception of 1901, when it was exactly the same. And this result was obtained although taxes were included in 1909 and not in 1901. The inference from the figures given by the Pennsylvania Railroad is that since 1894 the unit cost of handling freight upon that system has remained about stationary, fluctuating somewhat in either direction from year to year.

What Changes Will the Future Bring in Operating Costs?

The question for our consideration is, What is likely to be the result of these contending influences for the future?

Beginning in 1896 the cost of materials and supplies of all kinds rapidly advanced up to about 1902, since when there has not been, on the whole, much change. Supplies were somewhat lower in 1903 and somewhat higher in 1907, but they had fallen in 1910 to below the average for the last five years. The Baltimore & Ohio R. R. filed a statement showing the unit cost of and the total amount paid for the various supplies purchased by it in the years 1907 and 1910, from which it appears that, applying to the supplies actually purchased in 1910 the prices of 1907, the total would have aggregated about $500,000 above the amount actually paid in 1910. This does not include the item of coal, in which there may have been some trifling advance upon that system, and in which a material advance seems to have occurred upon some Western lines.

It seems probable that lumber of all kinds, of which large quantities are used in railway construction and operation, may increase in the future, since the supply itself is limited; but this increase is quite likely to be offset by the introduction of changes in the use and the substitution of one material for another. The treated tie will take the place of the untreated tie; iron will be used instead of wood; concrete is already being substituted for both wood and iron.

There is also likely to be some gradual advance in the price of coal, and this is, of all items, the most important to the railway. This advance will not be considerable, unless there should be some general increase in the wages of mine workers, which, again, is hardly likely under present conditions.

It seems fair to assume, therefore, that the general cost to the railroad of its supplies will not be greater in the immediate future than it has been in the immediate past.

The same remark would seem to apply to wages as they stand after the recent increases. Railroad labor, certainly organized railroad labor, is probably as well paid, and some say better paid, than labor of other kinds, upon the average. Railroad employees will hardly expect to receive wages which exceed those paid to other forms of labor for the same grade of service, and this Commission certainly could not permit the charging of rates for the purpose of enabling railroads to pay their laborers extravagant compensation as measured by the general average compensation paid labor in this country as a whole.

It is likely, therefore, that the labor item of these railroads will not in the immediate future much increase unless there should be a general advance in all prices.

The demands of the public will continue to add both to the expense of operation and to the cost of the plant. Greater safety of operation will be insisted upon and this will require the outlay of considerable sums upon way and structures, and also extensive changes in equipment, and will still further add to the cost of operation itself, by requiring the employment of additional men and the use of those men under different conditions.

It is also probable that taxes will continue to increase more rapidly than the increase in the value of the property.

Just how much all this will add to the cost of operation or to the capital account upon which earnings may be demanded can not be predicted with any degree of certainty.

It was said by railway representatives that this increase in expenses can no longer be offset by the introduction of further economies in the future as in the past, and it seems probable that the same sort of economies can not be relied upon to the same extent. Grades have been already reduced and curves eliminated, so that little remains to be done upon our first-class railway systems in that direction. Cars and engines are about as large as they profitably can be. An examination of the statistics of the Pennsylvania Railroad, the New York Central, and the Baltimore & Ohio shows that for the last five years there has been but little improvement in car loading or train loading. The president of the Baltimore & Ohio testified that his road was not yet in shape to handle its traffic in the most economical manner and that a large sum of money had been appropriated for the purpose, in part, of bringing that property up to a higher state of efficiency, but it is generally understood that upon the New York Central and the Pennsylvania this work has been substantially finished.

The Application of "Scientific Management" to Railway Operation.

It was, however, earnestly insisted by the shippers that the railroad might and should find other kinds of economies with which to make good this increase in wages. Several prominent manufacturers testified that in their business in recent years wages had been advanced, but that they had not been able to make corresponding advances in the price of their product and were therefore forced to look about for other ways in which to take up the increase in the cost of production. It was claimed that by the introduction of what was termed "scientific management," the purpose of which was in various ways to make labor more efficient, at the same time increasing the wage paid the laborer himself, much more than the amount of these advances could be saved.

One gentleman, who described these methods, testified that they had been introduced to some extent into the operations of railways with remarkable results, and that from a careful analysis and computation he was satisfied that not less than $300,000,000 annually could be saved by the proper application of these methods to the business of railroading in the United States.

It is difficult to see exactly what application the Commission can make in this case of this testimony. The witness who apparently had most to do with originating and applying these methods testified that they were in actual operation in not over one-tenth of 1% of all the manufacturing establishments of this country. The system is everywhere in an experimental stage. To some extent it has been tried and is now being tried by our railways. The representatives of railway labor who appeared before us stated that these methods could not and should not be introduced into railway work. Upon this record we can hardly find that these methods could be introduced into railroad operations to any considerable extent, much less can we determine the definite amount of saving which could be made. We can not therefore find that these defendants could make good any part of these actual advances in wages by the introduction of scientific management.

No general advance in rates should, however, be permitted until carriers have exhausted every reasonable effort toward economy in their business. The inducement to adopt methods of this kind which necessity creates in private occupations does not exist to the same extent in railroad operations. We can not escape the impression that railroad operators have not given to this important subject the attention which it deserves. An examination of the statistics before us shows the widest divergence in the cost of doing the same thing upon different railroads. It appears, for example, that the cost of maintaining locomotives per train-mile for the year 1910 was 9.22 cts. upon the Baltimore & Ohio as compared with 6.15 cts upon the Boston & Maine. It is impossible to resist the conviction that our railroads have not in the past given sufficient attention to these details, and while we can not to-day upon this record find that greater economy can be or ought to be practiced, railroads in the future must be prepared to explain these apparent differences in their operating costs and to show reasonable diligence.

Some Examples of Monopoly Effects in Railway Rates.

The railroad is a monopoly. Its rates are not made under the influence of competition. The significance of this is forcibly illustrated by what developed at a recent hearing in Chicago touching grain rates by lake and rail from Chicago to the seaboard.

It is well understood that package freight is carried from the seaboard to Buffalo by rail and from Buffalo to Chicago by water at a rail-and-lake rate. The steamers which handle this business from Buffalo to Chicago are all owned by the railroads, and the rates for the handling of this traffic are made in exactly the same way that the rail rates are and bear a certain relation to the rail rates. Within the last six years these rates have been twice advanced, in each case the water carrier receiving the entire advance, and it is now proposed to advance them for the third time.

Grain moves in large quantities from Chicago to Buffalo. While it is carried by these line boats which handle the package freight to some extent, it moves mainly by tramp vessel at rates which vary from day to day and which are highly competitive. Now, it appeared in the investigation referred to that while the rates upon package freight upon the Lakes had been steadily advanced, the rate of lake carriage upon this grain from Chicago to Buffalo had within the last five years declined from 10 to 25%. The vessel owners stated that the equipment in which this business was handled was the same now as then; that the wages paid their employees had advanced, but that, owing to competition, it had been found impossible to increase the rate.

The transportation of this grain from Chicago to Buffalo is really a part of its through carriage to the point of consumption beyond Buffalo. It moves by water up to Buffalo and by rail from there to destination. Now, while within recent years the lake part of this rate under open competition has declined, the rail part has increased by nearly 100%. Seven years ago the rate on ex-lake wheat from Buffalo to New York was 3½ cts per bushel. To-day it is 6½ cts. This does not show that the lake rate on grain is sufficiently high, nor that the rail rate is too high, nor is it certain that this intense competition finally redounds to the benefit of the public, but it does show the wide difference between these railroad charges before us and competitive prices.

Effect of Monopoly in Railway Purchases.

The vice-president of a railroad company testified during the hearing that his company could buy locomotives of but two concerns; that on account of the freight rate, as a practical matter, it could buy Bessemer steel rails of only two companies; that structural iron of the larger sizes could only be procured from four or five companies; and that in the purchase of cars he was confined to seven or eight independent plants. It is well understood that in recent years the price of structural steel in larger sizes and of steel rails has been uniformly maintained. It is also well understood that the same men who are potential in the United States Steel Corporation and the American Locomotive Works are influential in directing the policy of our railroads.

Now, if the steel trust is to determine the price which shall be paid for rails and for bridges; if the locomotive trust is to determine the price of engines, the car trust of cars, and the labor trust of labor, and if the railways have only to meet the demands made by these combinations and charge over to the public by an increase of rates whatever is paid, a most unfortunate situation has developed.

There is nothing in all this which enables us to say that railways do pay extravagant prices, and if we are satisfied that present rates do not yield an adequate return we should, notwithstanding these conditions of monopoly, unhesitatingly approve an advance; but in view of the monopolistic character of the business we should proceed with caution.

Business, both freight and passenger, will continue to increase but not probably at the same ratio as for the past 15 years. Even if this increase in business does not lessen the unit cost of operation it ought to contribute to the prosperity of the railways, since the

cost of the plant does not, ordinarily, increase as rapidly as do gross operating revenues. Thus, the amount of capital invested in the railroads and equipment of the United States, as shown by their capitalization, increased in 10 years, from 1899 to 1909, but 41%, while the units of traffic increased 81% and gross receipts 88%.

It should also be noted that while increase of business is ordinarily of advantage to a railroad and should ordinarily tend in the direction of lower rates, there may be, as applied to individual railroads, possibly as applied to railroads in particular localities, an exception to this rule.

Should Huge Outlay for Passenger Terminals Be Charged Against Freight Traffic?

It may not be at all certain but that increase of business in densely populated sections may even in the long run be a damage rather than an advantage, mainly by reason of the enormous terminal expenses which are necessitated in caring for this business. Within the last seven years the Pennsylvania Railroad has expended $100,000,000 in providing a passenger terminal in the city of New York, more than the entire capitalization of the Pittsburgh, Fort Wayne & Chicago, over which the greater part of the traffic of the Pennsylvania system moves between Pittsburg and Chicago. When its passenger improvements are completed in the city of New York, the New York Central will have expended in that betterment $82,000,000, nearly one-half the capitalization of that magnificent property, the Lake Shore & Michigan Southern Ry., which in the year 1910 earned above its fixed charges a corporate income exceeding $16,000,000.

It may be worthy of consideration just how far these freight rates can properly be increased on account of these extremely expensive improvements required by the passenger service of those lines.

How the Law Has Benefited Railway Revenue

During the last 15 years the net result from all these causes which we have been considering, increased cost of operation, increased wages, the public demand for a better railroad, increase of traffic, and economies in the handling of that traffic, has been very greatly to the benefit of the railroads. This improvement was especially marked up to 1900, but since then, while the year ending June 30, 1908, was a poor one, and that ending June 30, 1909, not up to the average, there has, on the whole, been a steady advance, so that the year 1910 saw the highest point in net railroad earnings, estimated upon any basis. There has, however, entered into this result, as a most important factor (which must not for a moment be lost sight of by one who would correctly forecast the future), an increase in the rates of transportation. These increases have mostly occurred since the year 1899, and have arisen in several ways.

In 1896 the payment of rebates upon competitive traffic was almost universal. The effect of this upon net revenues was fully appreciated by intelligent railroad operators, and many attempts were made to stop the practice and secure a maintenance of the published tariff. Beginning about 1900 these efforts bore fruit in certain quarters and the rebate gradually disappeared, being finally in main eliminated by the Hepburn amendment of 1906.

It is impossible to say how much has been added to the net receipts of the railroads from this cause but the amount is great.

Within the last few years a great many concessions which competition had forced in the way of special privileges have been withdrawn or are now charged for. In former days free storage was accorded; demurrage rules were but little enforced; traffic was held indefinitely for reconsignment; reconsignment was permitted without charge; switching was absorbed; free cartage was accorded, etc. To-day storage and demurrage charges are rigidly enforced; in some places track storage charges have been established; the privilege of free reconsignment has been much curtailed. The same process has gone on in reference to numbers of similar concessions, and this, while but little in the individual case, has amounted to much in the aggregate

The tariff rates themselves have been in many cases advanced. This has been true of the rates upon soft coal from the mines to tidewater. It has been true of rates upon grain and grain products from Central Freight Association territory and upon ex-lake grain, as well as upon many of the coarser commodities. The tonnage of these articles is enormous and the resulting increase in revenue must have been considerable.

While the gross amount of the increase resulting from all these sources can not be definitely known, it is indicated in Official Classification territory by the advance in the rate per ton-mile. The average per ton-mile rate of the Pennsylvania in 1900 was 5.04 mills; in 1910, 5.80 mills; of the Baltimore & Ohio, in 1900, 4.56 mills; in 1910, 5.77 mills; of the New York Central, in 1900, 5.58 mills; in 1910, 6.25 mills.

To recapitulate:

The cost of supplies will not much advance.

Wages will not much increase.

The demands of the public will continue to grow.

Traffic will increase, but the same advantage may not accrue to carriers in this territory in the future as in the past.

Something should be expected from the introduction of additional economies, but perhaps not to the same extent as in the past.

During the last 11 years the rate has advanced. Should it further advance, which now means, Should the published tariff be advanced?

In answering this question with respect to the three systems selected as typical, we should inquire:

What were the net revenues for the year 1910?

What would those revenues have been had the present wage scale been applied to the operations of that year?

Would the revenues resulting from the application of the present wage scale to the operations of the year 1910 have been sufficient for that year?

Will the revenues which would have resulted in 1910 from the application of the higher wage scale be likely to increase or decrease in the future, and if sufficient in 1910 will they continue to be adequate?

[The detailed discussion of these questions for the three systems considered is necessarily omitted here.—Ed.]

We have examined the accounts of many other lines operating in this territory and affected by these increases, but fail to find anything in the financial condition of these remaining defendants which should induce us to modify whatever conclusion is reached from an examination of the three systems selected.

Upon a view of the whole situation we hold that these defendants have not established such a need for additional revenue as justifies, at this time, an increase in these rates.

In announcing this conclusion two observations should be made:

First. It has been several times stated in the course of this discussion, and should be repeated here, that in view of the complex character of this problem, nothing but an actual test can satisfactorily determine the financial results from the operations of these several carriers. There is no evidence before us which establishes the necessity for higher rates. The probability is that increased rates will not be necessary in the future. In view of the liberal returns received by these defendants in the past 10 years, they should be required to show, with reasonable certainty, the necessity before the increase is allowed. If actual results should demonstrate that our forecast of the future is wrong, there might be ground for asking a further consideration of this subject.

But it should be further said that before any general advance can be permitted it must appear with reasonable certainty that carriers have exercised proper economy in the purchase of their supplies, in the payment of their wages, and in the general conduct of their business.

Second. We have been compelled to dispose of this case upon the evidence available. As previously noted, there is no testimony tending to show the cost of reproducing these properties. It is plain that a physical valuation would introduce into the calculation a new element which might lead to a different conclusion. The conclusion reached here extends, therefore, no further than the facts upon which it is based.

This Commission has several times urged Congress to authorize a reproductive valuation of those railroads subject to Federal jurisdiction. It is reported that certain railroad companies are making such valuations themselves, and the results may at any time be urged upon this Commission and the courts as a justification for higher rates. The interest of the public ought not to depend upon a valuation made entirely by the owners of these properties, no matter how honestly the work may be prosecuted.

The Preservation of Macadam Roads in Scotland.

The maintenance of macadam roads in Scotland has been reported to the U. S. Bureau of Manufactures, Department, of Commerce and Labor, by Consul Rufus Fleming, and has been printed in the daily consular and trade reports of Jan. 27. Mr. Fleming has relied largely on results of the observations of the Edinborough County Road Surveyor. General methods of work are disclosed, as shown below. It is said that in Scotland, as in England, most county road boards are abandoning the use of tar on account of prohibitive cost. Spurinkling of 10 or 12 ft. in the middle of the roadway is there regarded as the limit of economical treatment of macadam on main thoroughfares or village streets of the more outlying sections. The use of pitch binders, however, is expected to increase on purely suburban roads.

"TAR SPRAYING."—After cleaning off all dust and mud tar is sprinkled on as a waterproof protection rather than as a binder for the metal. Hand sprinkling is considered more beneficial than machine, though more expensive. Screenings are spread after tarring. The life of a surface is increased by 15 to 20%. The annual cost is $1,460 per mile per annum, but nothing is said about the number of applications.

"TAR MACADAM."—As put down here, these surfacings are slippery in frosty weather and unsafe for grades of more than 5%. The first cost is heavy and the life is only two or three years under heavy traffic. The stone is thoroughly mixed with tar and pitch previous to laying. Demand for dry stone necessitates working under cover. The tarring is done by both hand and machinery and ordinarily the material lies in heaps from one to three weeks to mature. Coatings are applied in three layers: First, one of 2½-in. stone; second, one of 1½-in., and third of 1-in. Each coat is rolled separately and the road is finished with fine dry screenings.

"PITCH GROUTING."—This is essentially what is called "penetration work" in America. The road is scarified and 3 or 4 ins. of broken stone put on and rolled dry. Then boiling pitch and tar is poured o nand covered with small stone or gravel. Finally, the road is rolled until hard. The binder is made up of 11 parts of best coal tar pitch, 8 parts of heavy-body refined tar and 1 of creosote oil. This is quick setting, but retains some viscosity. Care is taken to secure a dry road before tarring. The surface is smooth but not slippery, and for country roads it is dustless. The life of macadam so prepared is increased by about a third. No costs are given.

"TAR MATRIX."—After scarifying, a layer of tarred small gravel is spread, 1 to 1½ ins. thick. On this is placed ordinary, broken stone, which is rolled until the tar matrix comes to the top. A second method consists of placing the stone on the road first and rolling it. Then the tarred gravel, containing up to 1 in. size, is spread 1 to 1½ ins. thick. This is rolled until the matrix is forced around the stone and a smooth surface is obtained. A third method (the Gladwell system), consists of applying a matrix layer both above and below the broken stone. In all methods a thin coating of fine tarred material is usually applied, sprinkled with sand or screenings, and rolled.

"WATER-GLASS MATRIX." — Experimental roads have been laid by a so-called "Rocmac" system, and which are claimed to be dustless, waterproof, durable and non-slippery. The binder is said to be largely a solution of sugar and sodium silicate (water glass), made under pressure. This binder is mixed with ½-in. limestone and clean gravel. The material is laid, about 1½ ins. deep, on a scarified road, and is covered with ordinary broken stone to a depth of some 3 ins. The road is then thoroughly rolled so that the matrix comes to the top. The preparation of the material is reported to be simple, but its use is rather more expensive than pitch groutings.

GARDEN CITIES AND GARDEN CITY SUBURBS in England now number 17, ranging in size from an area of 53 acres to 3,818 acres. The general principle followed in laying out these areas is to give those who must live in or close by cities the maximum amount of garden and other open space consistent with low rental-value houses, and at the same time to secure as much as possible of esthetic value. The following list of the 17 garden areas, with designation of whether they are suburbs of some city or more or less independent communities, has been taken from the diagram published in the London "Contract Journal" for Feb. 15, 1911:

Name.	Class.	Area in acres.
Harbourne	Suburb	53
Ealing	Suburb	60½
Anchor Tenants	Suburb (Leicester).	60½
Hull	Village	90
Earswick	Village	120
Woodlands	Village	127
Liverpool	Suburb (Wavertree)	185
Hampstead	Suburb	240
Glyn Cory	Suburb (Cardiff)	300
Port Sunlight	Village	350
Fallings Park	Suburb	400
Romford	Suburb	500
Nast Hyde	Suburb	500
Bournville	Village	525
Knebworth	Village	1,000
Northwood & Ruislip	Suburb	1,300
Letchworth	City	3,818
Total acreage		3,577

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How steep a grade is it safe to operate electric cars over? To put the question in other terms, what is the best way to operate an electric railway with grades over 12%?

The best answer that we can think of to this latter question is not to operate it at all, but to cut down the grade! Unfortunately, however, it is not always or often possible to do this. The streets of American cities have been nearly always laid out to suit the seller of real-estate, without regard to the limiting gradients; and it is often necessary to run a street railway line up a hill much steeper than ought to be permitted on any public street.

In the early days of electric railway work, neither the motors nor the brakes were powerful enough to permit operation over very steep grades. In a number of cases in the West, cable street-car lines were converted to electric operation, and the problem of safety on the steepest grades was at once presented. Familiarity with the cable system doubtless led to the development of the so-called cable counterweight method of operation. A shallow conduit or tunnel was constructed under the track, and in this was placed a cable and counterweight car.

A number of such lines were built in the Northwest ten to fifteen years ago. The method of operation is more or less cumbrous, however, and some of these lines have been abandoned. At Seattle, on one of these lines where the cable counterweight has been discarded, electric cars are now running over 16% grades. A track brake is used in addition to the wheel brakes, however. On one line in St. Paul, where the counterweight system was abandoned, a tunnel was driven under the street through which the electric cars are now run. In a third case at Portland, Oregon, the branch on which the counterweight cable was used has been abandoned.

There are still, however, some cases where grades above 10% are used on electric roads, and where the cable counterweight system has a limited field. Elsewhere in this issue we illustrate one of these lines with a grade of 15 to 18%. This is not a new installation, but it has been altered and improved since its original construction.

It may be well to add that while experience has shown that with motors of sufficient power and brakes of sufficient strength and security grades steeper than 10 to 12% *can* be operated by electric traction without any auxiliary aids, experience has also shown that there is more or less liability to accident on such steep grades. They are a nuisance to the operating department because of the more or less frequent difficulties in starting cars on them. When the weather and the rail are bad, they put a heavy stress on the motor and brake equipment and a heavy load on the power station, and there always exists a chance that a car with weak brakes or with brakes which become ineffective for any reason may cause a bad accident, with loss of life and damage suits that will result in a very heavy bill of expense for the operating company. It seems to us on the whole, therefore, that the best practice in electric railway engineering is to reduce the maximum grades that were originally considered feasible of operation rather than to raise the limit.

On another page of this issue we publish the larger part of the very interesting paper on the Aziscohos Dam in the Rangely region, Maine, read by Mr. Seth A. Moulton before the recent annual convention of the National Association of Cement Users. The construction of a large storage dam so far away from modern transportation facilities that all materials except timber, has to be "toted" in by team is in itself of sufficient novelty in these later days to warrant notice, although there have been several recent instances in the Far West, where this same thing has been done.

The notable feature of the Aziscohos work is the application of economic principles to the solution of the transportation problem. Consultation with the local teamsters, who represented the best current knowledge of the subject, showed that the amount of material possible to be carried in by team over the country roads would not begin to furnish the work sufficiently to permit its being conducted economically. Thereupon, the engineers instituted a study of the problem from an engineering standpoint precisely as though the goods were to be carried over a single track railroad with numerous sidings and turnouts, and as a result of these studies managed to develop a system which, in the first season, more than doubled the estimated delivery of the local teamsters.

The essential elements of this scheme were the making of a schedule of trips to which the teamsters were forced to adhere and the application of the shuttle train system, whereby lightly loaded wagons were hauled over the heavy grades to intermediate stations where the larger through teams could pick up extra loads to carry over the easy grades. Under its very orderly working as many as 40 four, five and six-horse teams were kept in service during rush periods, hauling for 38 miles over what are, in certain seasons, possibly the worst roads in this country, loads varying from 1,220 to 1,680 lbs. per horse. As the trip took two days each way, ten teams arrived at the dam site each day during this rush period with a daily total delivery of 30 tons. For a period of 335 days, ending just before Mr. Moulton's paper was prepared, the cost of the hauling was about 45 cts. per ton-mile.

We call attention to this portion of the paper in order to emphasize the application of principles of economic location and operation to the construction of and transportation over ordinary roads as well as on the railroads for which these rules were originally pointed out by Mr. Wellington. It is not often that the engineer has occasion to apply them to transportation over roads already built, as in the case in hand, but as we pointed out editorially some months ago (Engineering News, July 14, 1910, p. 50) there are many instances where an annual saving could be made by an initial extra expenditure, resulting from a study of the effect of rise and fall, and incidentally of grades, on the cost of hauling over the ordinary highway.

Pier Encroachment on the Hudson River at New York.

If persistency is a virtue, the International Mercantile Marine Co. and the New York City dock authorities will go down on the records with at least one virtue to their credit. The story of their actions since 1902 in the matter of applying for pier extension permits at New York City, as given in an article on another page, demonstrates nothing if not a bulldog persistency. Five successive rejections of their application for a permit for pier encroachment have not discouraged them, and they have continued to hold out the mendicant hat until they got a coin, though it may be smaller than they looked for. The story contains more than one element of human interest.

Reducing the case to its skeleton, it consists of the simple fact that although eight years ago the Federal authorities said emphatically "You may not build your piers farther out into the stream," and the steamship people thereafter began to plan and build a larger vessel than these piers could receive, no attempt was made to find quarters suitable for them, though there was ample time, seven years; and that, having entered into occupancy of these piers, they come again to the government and say, "Here we are; our larger ship is coming; we must lengthen the piers and you *must* grant the necessary permit." Surely this is the extreme of standing pat.

And this time they came to the attack with such extensive backing as to arouse wonder at the source of their influence. Almost without exception the newspapers of New York City joined in hysterical outbursts, using such phrases as: "driving from this port the transatlantic trade," imperiling the commerce of the whole nation," "the destruction of the supremacy of the port," or, "the transcendent importance to the transportation industry of the nation of the decision he (Secy. Dickinson) must make." Even those of the daily papers which should be the best informed joined in the hue and cry. And, after the adverse report of the Harbor Line Board, even the Governor of the State, the Mayor of the city, and the Vice-President of the United States lent themselves to making a personal appeal to the Secretary of War. In the meantime, such experts on navigation and river administration as the dry goods men, the Hotel Men's Association, and the Chamber of Commerce, gave out their opinion that to deny the permit sought for would be a crushing blow to the city. Perhaps it is not surprising that the Secretary of War gave ground under the pressure.

Evidently, few of these estimable persons and organizations gave thought to the greater importance of maintaining proper river width and prohibiting isolated encroachments, or to the question whether it is reasonable to inconvenience a traffic of 2,000 vessels per day for the benefit of one ship per fortnight. If they did consider these things, they may have been impressed by the assertion of Dock Commissioner Tomkins that it is absolutely impossible to provide for the "Olympic" except by extension of the piers, an assertion flatly contradicted by the statement of the Harbor Line Board. Or they may have taken alarm at the insinuations of the steamship agents that they would move their terminals to some other port; as though the steamship lines come to the port of New York because of their friendly feelings toward the city!

The reasons why the asked-for encroachment on the Hudson should not be permitted would have full force even if the new 900-ft. ships represented a real and lasting feature of ocean commerce. But the fact is, as we pointed out some months ago,* these ultra-large vessels are little more than monstrosities, desired mainly for their advertising value, like the biggest elephant, or the highest skyscraper tower. Sir William White himself has stated that naval architecture is not at all the limiting factor in building larger ships, but is capable of producing even much longer vessels than any yet proposed; that commercial considerations set the limit, though of course rather indefinite

*Eng. News, Oct. 6, 1910, p. 366, "Will It Pay to Build Larger Steamships."

ones." Should, therefore, the White Star people conclude next year that they want a 1,500-ft. liner, they could get it built, and they could then ask for 600 ft. of further encroachment on the Hudson with precisely the same arguments as they have spread broadcast during the past two weeks.

Though this case may seem to have only local importance, yet it is of much wider concern, because the practice of encroaching on public thoroughfares is exceedingly common. It is an easy and profitable practice; so easy, in fact, that encroachments once established are, like weeds, almost impossible to root out. In street encroachments, New York City affords perhaps the finest and most complete exhibit in the world. Encroachments on streams and other waters, however, are found most in small cities, or away from cities. It might be expected that important harbors and commercial water-highways should stand forth as models of strict control of encroachment. And for this reason, if for no other, it is regrettable that the present ill-grounded attempt to take from the channel width and add to the land was not rejected as were its numerous predecessors.

A further feature, injected into the case when the adverse opinion of the Harbor Line Board became known, is the proposal for a *temporary* permit, i. e., not a shifting of the established pierhead line but a permit to maintain a structure beyond the line until such time as other provision would be made. This proposal was based on the claim that the longer ships could not be provided for elsewhere, at least not in time for the arrival of the "Olympic" in June; the claim is not generally admitted, and may mean no more than that it is not convenient to the Dock Department to undertake other provision. In any case, no one who has observed the strange tenacity of "temporary" obstructions and encroachments can have any sympathy for the request. Our impression is that the War Department already has several cases of trouble with "temporary" authorizations which will not allow themselves to be killed off.

The responsibility for the present state of affairs, we regret to say, rests largely on the New York City dock authorities, who with years of time made no preparations for what changes were in prospect. The coming and going of the political heads of the Department of Docks & Ferries is not sufficient excuse, in this instance. For, Mr. Calvin Tomkins has been Commissioner at the head of this department for more than a year, yet *he has done absolutely nothing* to provide for the "Olympic," until his eleventh-hour emergency plea for the special privileges which the department and the shipping companies coveted. Under these circumstances, there is some hope in the establishment of a joint commission of the states of New Jersey and New York and the War Department, to consider broadly the development of the port.

The Proposed License Laws for Engineers in New York State.

A meeting was held in New York City on Feb. 21 by a number of leading engineers, including representatives of each of the four great national engineering societies. After discussion a resolution was adopted expressing the unanimous opinion of those present that the passage of any engineering license bill whatever in the State of New York would be contrary to the interests of the engineering profession and the public. A committee was appointed to arrange for representation at hearings on the pending bills to be held by the legislative committees.

The first of these hearings was held on the Hoff Bill on March 1 by the House Committee on General Laws. This bill was framed on the general lines of the bill drafted by a committee of the American Society of Civil Engineers. It was a blanket bill including every branch of engineering practice and occupation, except military engineering.

The delegation which appeared in opposition to this bill on March 1 included prominent representatives of the American Societies of Civil, Mechanical, Mining, and Electrical Engineers and of the American Institute of Consulting Engineers. There were also representatives of the Albany Society of Engineers and of the faculties of the principal engineering colleges of New York State.

A large part of the time at the hearing was consumed by an attorney who represented the Technical League, a secret organization of New York City. This attorney opposed the Hoff bill, on the ground that the Technical League preferred the McGrath bill, which is similar to the Raidiris bill offered in the Legislature last year.

The only two spokesmen who defended the Hoff bill at the hearing admitted that they did so only in the belief that such a law would be less objectionable than the law proposed a year ago, or than the McGrath bill, and that they would be entirely satisfied if the Legislature refused to pass any law for licensing engineers.

From the showing made at this hearing, the Hoff bill ought never to be heard of again, and certainly will not be unless there are some underground political forces which aspire to control the engineering profession in New York State and which have their own reasons for desiring to place such a law on the statute books.

The defects of this law have been so well shown in these columns during the past weeks that no further argument against it should be necessary. It may be assumed that the Gittins bill, introduced in the Senate on Feb. 7, which is practically identical with the Hoff bill, will have a similar disposition.

On March 14 the Assembly Committee on Education will hold a hearing on the McGrath bill* This is the bill put forward by the secret organization already referred to—the Technical League. There has been absolutely no evidence from any quarter whatever that there is any demand for the passage of this bill, as regards the alleged purpose of protecting the public against malpractice.

The idea which appears to have animated the sponsors of this measure is that its passage will, in some unexplained way, place engineering practitioners, and particularly those in subordinate positions, on a better footing in their relations to the public and particularly their relations to their employers.

The young men who are attempting to secure this legislation are doubtlessly perfectly honest in their beliefs, but they are certainly wofully misguided. They are attempting to impose upon the profession a grievous and very serious burden and one which will bring no benefit, but injury instead, upon both the profession and the public.

The McGrath bill places the control of the engineering profession and of engineering schools in the State in the hands of the Board of Regents of the "University of the State of New York." This Board of Regents is made up of a dozen highly respectable gentlemen, nearly all of whom are either past the age of active life, or else have too many other lines of business to permit of their doing any real work in connection with the conduct of education in New York. It is interesting to record the ages of various members of this board of regents. The figures are as follows: 74 years, 66 years, 81 years, 71 years, 77 years, 61 years, 67 years, 70 years.

It is bad enough to put such a vital matter as the education of the young in charge of a body of men so long past the years of active progress; but to put the engineering profession, growing and developing as it is, under the tutelage and control of such a set of respectable figureheads is a proposition which should arouse a protest from every live engineer.

It may be said that this board of regents would have nothing particular to do with the engineering profession, except to elect the board of nine engineering examiners which would conduct the examinations and license those engineers who were able to pass; but it is seriously doubtful whether even the responsibility of selecting the engineers who would be given this autocratic power over the profession ought to be placed in the hands of such a board.

There is one feature in which the McGrath bill is a distinct improvement over the Hoff [illegible] It does not attempt to include mechanical [illegible]neering, electrical engineering, and mining [illegible]neering in its scope. Engineers practicing [illegible]ose branches of the profession can go on the[illegible]way, for the present at least, undisturbed. [illegible] McGrath bill defines the practice of civil [illegible]ering as follows:

"A person practices civil engineering who holds [illegible]self out as able to do plane, topographical or geode[illegible]rveying; design and construct public and private [illegible]ks, such as bridges, structural steel work for bu[illegible]gs, railroads, highways, roads, canals, river and [illegible]bor improvements, street improvements, sanitary wor[illegible]r- rigation works, water supply and such part of po[illegible]de- velopment work as a civil engineer is ordinarily [illegible]lled upon to do, which require experience and the sam[illegible]ech- nical knowledge as engineering schools prescr[illegible] for graduation; and the engineering inspection of all [illegible] the above.

We do not know what the words "hold[illegible]mself out" signify. Probably it would ta[illegible] the Supreme Court to interpret it finally. [illegible]s a man "hold himself out" as a structural en[illegible]neer if he applies to a bridge company for a [illegible]as draftsman, or to a railway company for [illegible]job as roadmaster, or must he be independe[illegible] in practice and hold out his shingle to the [illegible]ublic to come under the scope of this law? P[illegible]ssing that question, however, the bill declares that after Jan. 1, 1915, no person shall practice engineering, defined as above, unless he is registered and licensed by the Regents.

There is a large amount of detail in the law regarding the amount of engineering education that will be required before a candidate can take an examination for a license to practice. Apparently, the well-meaning young men who framed the law are anxious to confine all engineering work to the men who have graduated from engineering schools, although they do admit those with certificates from correspondence schools which have been approved by the Regents.

There would be no chance, therefore, under such a law for the young man who is through force of circumstances deprived of the opportunity of obtaining a regular engineering education ever being admitted to the engineering profession. The attempt to set up such a hard and fast rule argues a very limited acquaintance with the men who have made the greatest achievements in engineering.

It is surely needless to say in this place that Engineering News believes, in common with all intelligent members of the profession, in the work of the engineering schools and in an engineering education as a vast help to a young man in entering upon his life's work. Nevertheless, there have always been in the past, and we feel confident will be in the future, not a few men endowed by nature with the qualifications which bring great success in engineering work and whom the engineering profession should be proud to honor for what they have achieved in spite of the obstacles due to lack of education. It will be a sorry day for the engineering profession and a sorry day for any state when a law is placed upon the statute books forbidding a man to carry on engineering work simply because he has not had a certain preliminary education.

There is another vital objection to the McGrath bill. It proposes to issue licenses by which those who hold them are declared under the seal of the state to be competent to practice civil engineering. Under that head there could be enumerated, we are sure, not less than twenty-five and probably many more distinct special branches of civil engineering, any one of which is sufficient to demand all the energies of the ordinary man to become a master in.

The proposed certificate, however, sets forth that its holder is qualified to practice in any or all of these. Assuredly, such certificate and such a law gives no real protection to the public against incompetence. There is nothing whatever to prevent the holder of a certificate who, after some experience in structural work, for example, finds himself out of a job, hanging out his shingle as a sanitary engineer or a hydraulic engineer, or engaging in any other specialty in which he sees an opportunity. Admittedly, no honest and reputable man would so attempt to deceive the public, but the very idea back of this proposed legislation is that some incompetent men are at work in the profession and ought to

*The hearing will be held in Room 236, Capitol, Albany.

be shut out. This furnishes another reason, therefore, why the law would be a failure.

We are told, however, that there is throughout the country a large and growing sentiment in favor of State legislation for the examining and licensing of engineers. The legislation already enacted in Wyoming and in Louisiana is pointed out. It was recorded in these columns recently that the Ohio Society of Engineers had itself framed a bill for the licensing of engineers and urged its passage upon the Legislature. A new engineering society organized in Arkansas has also drafted a bill for presentation to the State Legislature.

It is worth while to look more closely at these state laws, proposed or enacted, in various parts of the West with reference to engineering practice and see what is really in the minds of those who are advocating them. When the movement is studied in this way it is at once found that what these Western engineers are really talking about is not civil engineering, in the broad definition given in the Hoff bill or the McGrath bill. It is primarily land surveying. The Arkansas bill, for example, relates only to surveying. Civil engineers are included in the bill merely because they are supposed to be competent to carry on surveying work, as well as whatever specialty in civil engineering work they may follow.

Take the bill recently introduced in the Ohio Legislature. This proposes three separate kinds of licenses: a license for land surveyors, a license for mine surveyors, and a license for civil engineers.

Now, as we have hitherto declared in these columns, there are sound arguments in favor of legislation requiring those who do work as land surveyors to be examined and licensed. An incompetent land surveyor may make blunders which will cost thousands of dollars of loss, in litigation or otherwise, half a century after his work is done. Besides this, surveying is a comparatively simple and elementary branch of engineering work, and it is quite possible for a board of examiners to test fairly the competence of a candidate to do accurate and reliable work. It may be that there are other elementary branches of engineering work which could be taken up by legislation and so defined and limited that those who practice them could be required to have examination and license. It must be borne in mind, however, that the limitations to the testing of a man's reliability by any form of examination are very definite. There are many very able men in the engineering profession who are carrying on a high class of work and who are as competent and reliable as could be found anywhere, who yet would make a very poor figure before an examining board, and would be lucky if they could pass at all.

One of the most curious of the ideas which seem to possess those who are advocating a license bill appears to be that the engineering profession would be, by such an enactment, given a more respectable and honorable place in the public esteem. What the grounds are for such a belief it is difficult to say. Perhaps it is based on the idea that the doctor or the lawyer stands higher in the community than the engineer. We doubt the correctness of that idea, but, even if it were true, the fact is that there are a very large number of doctors and lawyers possessing a state license and yet unable to practice their profession and engaging in all sorts of occupations to earn their living. Those who hold the idea that an official state license confers distinction should remember that while doctors and lawyers are licensed so also are barbers and saloon-keepers.

That this bill is urged with the idea of benefiting a single small section of the community and not with any pretense that it will benefit the public, ought to be sufficient to kill this bill before any intelligent legislative committee. If it were possible by process of law to enable the public to select for engineering employment only the men who were competent and trustworthy to carry out work in the best possible shape, then, by all means, such a law ought to be enacted. Those who think, however, that it would be possible to work such a miracle by any process of legislation are pursuing a will-o'-the wisp.

LETTERS TO THE EDITOR.

The Threatened Disintegration of the Passaic Valley Sewerage District.

Sir: Your editorial on "The Threatened Disintegration of the Passaic Valley Sewerage District" will be read with great interest not only by residents of that district, but also by the engineering profession at large, because it strikes at the root of some of the methods frequently adopted in financing and correlating aggregated sewerage works.

In your issue of Dec. 1, 1910, with this thought in mind, I called special attention to the Emscher District, uniting many communities, and to their laws and methods of executing work similar to that of the Passaic District.

The troubles besetting the Passaic Valley Sewerage District to-day may be summarized as follows: The law under which the work is to be done is strikingly unjust to some of the communities involved, as regards apportionment of cost of the proposed work. The law is also awkward in the practical methods prescribed for carrying out the work, and is injurious as regards efficiency and economy, in some restrictions upon constructive features of the work, by preventing the utilization at any time of the best engineering methods as they may develop—a most conspicuous case being the prescribed details of the late compromise with the United States.

If the troubles you have indicated already exist, there are still others clearly foreshadowed in the specifications of the present legislative act, which without question will arise in due time to further delay the work and increase its cost.

The general engineering features of the district sewer plan as regards efficiency and economy have, on the other hand, been developed from the beginning along the lines of ample experience in two continents. They have, however, been twice set aside in part through the influence of citizens, excellent advisers in their respective callings, most honorable in their intentions and most devoted in their endeavor to solve the problem, but insufficiently appreciative of the capabilities of modern sanitary engineering. Had the excellent plan of an intercepting sewer, as recommended by the prominent engineers, Fteley & Jacobson, over a dozen years ago, been carried out, we would have had a clean Passaic River for years, and the river nuisance would not have been transferred to Newark Bay, as was then feared by some citizens. Not until about the present time would it have been necessary to find a supplementary method for treating the sewage thus discharged, and as already partly suggested by the above-named engineers, either by a transfer of the outlet into the Kill von Kull or New York Bay, or by a prior partial purification by works built on land, or by some other means.

The details of the history of this important undertaking, as you have so fully stated them, should impress themselves strongly upon American communities, so that a repetition may not occur.

During my late trip to Europe engineers in both England and Germany were at a loss to understand the curious controversies on this subject, which of late have been exhibited in our great metropolis. The dispersion of the sewage in the center of the great Upper New York Bay, 40 ft. below the surface, was and is pronounced by the most experienced engineers as the best solution for us and one which would result in the fewest objections. These opinions were based chiefly on the assumption that all other means of satisfactory disposal are more costly, and that the cost is equitably divided between the beneficiaries. When, however, the law of the Passaic District forces the expense to be so inequitably divided that several of its communities can dispose of their own sewage in other ways at much less cost, it is not to be wondered that a disintegration of the district is threatened.

It would seem that the first and most urgent step to prevent this unfortunate result, as you have suggested, should be to change the law, so that the cost can be more justly distributed, the practical execution of the work better facilitated, and, after all the general preliminaries have been completed, the entire works of sewage collection and disposal, including the methods, can be placed directly into the hands of a responsible and sufficiently large body of experienced engineers, as in the New York Board of Water Supply, or in the Emscher District, all of which the present law makes difficult, expensive, and in part impossible.

Very truly yours,

Rudolph Hering.

170 Broadway, New York City, March 1, 1911.

Licensing Engineers.

Sir: On the subject of licenses for engineers, it occurs to me that there is some call for what might be called "Land Surveying Licenses," but that for higher branches there is seldom any true need of legislative action.

That there are a great many unqualified persons practicing the art of land surveying is, I take it, beyond question, and proof can easily be had by consulting the records of real estate transfers in almost any county court house. Especially in the country districts, the practice is apt to be very lax and any one who can plant a Jacob's staff and add up two and two, making it usually come to four, can, if he uses juddgment in selecting the place in which to hang out his shingle, find work to do. In many rural districts, competent land surveyors are so scarce that the land owner is compelled to employ whoever he can get.

A license system would probably in the long run improve this condition, because it would be possible to prohibit any new sub-division of land from going on record and thus becoming effective unless made by a licensed surveyor. Of course, the benefit would not necessarily be immediate, for any law which would stand the test of the courts would have to provide licenses for all persons practicing the art at the time the law goes into effect. At the same time, by allowing no new licensees to qualify unless they had some modicum of education and fitness for the work, the entire practice of land surveying could be considerably toned up. Concerted action among the different States would not be indispensable (although desirable), because land surveyors as such seldom cross State lines for their work. By weeding out incompetents, surveyors' fees could be brought up to and held at such a point as would attract good men to the field.

But, with engineers, the case is entirely different. As you have yourself pointed out, to require a general license covering engineering in all of its branches—saving the military art—is an absurdity. In many districts, it doubtless may be well, because of peculiar local conditions, to require licenses for those persons practicing some particular branch of the profession, as in Wyoming to license irrigation engineers; and I have no doubt, as the correspondent in your last issue has pointed out, that such a license system has greatly improved the character of the work of that nature done there. But a general license presupposes that the man who is competent to design an America's Cup Defender is also competent to lay down a railroad line through the Rocky Mountains or to build revetments on the Mississippi River.

The same writer, in order to strengthen his position as favoring licenses, has pointed out that public policy has required the licensing of physicians, pharmacists and lawyers. The point is certainly well taken as regards pharmacists, because the man on the street is not privileged to enter the druggist's prescription room and would have no way of knowing, were it not for such license, whether his pharmacist is alive to the difference between calomel and corrosive sublimate. As regards physicians and lawyers, the case is not so strong. The usual practice is to issue licenses as soon as the would-be practitioners leave school and before it is possible to tell whether they will ever develop into real (I almost said practical) professional men or no. How many licensed members of the bar are there who have never had a case at court? How many M. D.'s are driving street cars in our great cities? And yet, how many licensed charlatans there are in actual practice with large clienteles! When I select a family physician, I do not ask to see his license—I take it for granted that he has one—but I do enquire into the man's antecedents and the success which he has made in his chosen line.

In the same manner, if an individual or corporation has a large engineering work to be designed, they have themselves to blame if they do not look well into the professional standing of the engineer whom they place in charge. If they are wise, no matter what his presumptive engineering license may have to say as to his competence, they are not going to hire a reinforced-concrete specialist to design a trickling filter, or an electrical engineer to build city streets, and the most of us would blush if we had to display a paper arrogating unto us qualifications which we very well know we do not possess.

It is true, probably, that very few laymen know anything about the American Society of Civil Engineers; but no more are they likely, after the novelty of the thing has worn off, to know much about the engineering license laws. How many thousands of laws are there on the statute books to-day that the lawyers themselves have nearly or quite forgotten about? We have Congresses, Legislatures and Councils turning out statutes and ordinances by the train-load: Of these, it is only those in which we are peculiarly interested or those having such striking or important features as to provoke general discussion that we ever hear of. It is true that the divorce laws in force in Reno, Nevada, are notoriously peculiar; those in South Carolina are even more peculiar—by their entire absence—but how many of us know such to be the fact?

Unfortunately, the average man thinks—just as he does in the case of the minister of the Gospel—that he knows more about our business than we do ourselves. If a system of licenses could disabuse his mind of this idea, I would hail my license as indeed the breaking forth of the sun of prosperity; but our fathers discovered centuries ago that personal opinion is not

amenable to the law books, nor will legislation take the place of education.

If such were the fact, then pass a law compelling all persons whatsoever having engineering work to do to turn the matter over to their professional man and require them to trust in him just as implicitly as the most of us do in our doctors and lawyers, and the matter would be settled! Right here lies another difficulty: the proposed license laws would be exceedingly difficult if not impossible to enforce, because it is impossible to make them clean-cut. Who can say just what work must be done by a licensed engineer and what work anybody can do? Where does the work of the engineer end and that of the "practical" man begin, especially if the client is disposed to exalt the knowledge of himself or other "practical" man over that of the engineer?

For these reasons, I think that the compelling of engineering licenses, except in specified branches and over limited territories, would not only be of no benefit whatever to either the general public or the engineering profession, but would actually be a hindrance and a stumbling block to both. Yours truly,

D. S. Newton,
Assoc. M. Am. Soc. C. E.

Jamestown, N. Y., Feb. 27, 1911.

[We may add to our correspondent's comments on the licenses issued to Doctors of Medicine by printing the following press dispatch dated at Chicago, Feb. 27.—Ed.]

Dr. Alexander Hugh Ferguson, President of the Chicago Medical Society, in an address of welcome to members of the Association of American Medical Colleges, said to-day:

"The medical profession is overcrowded. It is not overcrowded by the survival of the fittest, but by the survival of the unfit.

"With a population of about 90,000,000 in North America, we have at least 120,000 who are legally licensed to practice medicine. This is about one to every 800 inhabitants. In England the proportion is one to 1,250; in France one to 2,175, and in other countries the proportion is still more favorable to the medical profession. To sum it up, we don't need more doctors, but we do need a better brand."

Sir: I notice a letter by myself in Engineering News of Feb. 23, and also one by A. DeW. Foote and also your editorial of the same date.

On reflection, I think your editorial contains the gist of the whole matter. Mr. Foote's article is too condemnatory of license, because virtually it includes all engineering including the elementary portions, and he gives the impression (to me at least) that he opposes any and all regulation of even ordinary surveys by law in any way, shape or manner.

My letter states that I do not believe that members of any of the great engineering societies should have to take out a license; that their qualifications have been passed upon once and that is sufficient. But the trend of my letter is to show that so far, licensing in Wyoming has proved beneficial. I would here like to qualify my statement, however, by saying that nearly all of the work done in this state is rather elementary in its character. It is true we have many great irrigation and other works, but the vast majority of all our irrigation work is concerned with small ditches and reservoirs. This qualification of course reduces my statement to agree largely with your editorial, which says:

If the legislature of any state sees fit to pass a properly framed law requiring every one who practises land surveying, or who is a structural designer, or who is engaged in building municipal supply plants to be examined we can see some valid arguments to be brought in support of such measures.

This is the true nature of my contention.

I would also state that it has been the general rule in this state for the Examining Board to admit all full members of the American Society of Civil Engineers without examination, if the applicant so desired it. We have so far had no applicants from the other societies. I would also say that some full members have preferred to stand the examination and have done so of their own free will.

Now, admitting that some regulation as to surveying might be beneficial, or that some restrictions should be placed on elementary work, the question arises "Where shall we draw the line?"

W. Newbrough, M. Am. Soc. C. E.

Evanston, Wyo., Feb. 25, 1911.

Notes and Queries.

M. W. J., Albany, N. Y. (who forgets to sign his real name) criticises the comparison between the profits of the Pullman Company and the express companies, on p. 105 of our issue of Jan. 26, because the former were for 1908 and the latter for 1909. In reply he is informed that statistics of the two for the same year were not available at the time; and for the broad general comparison, it was not considered essential that the statistics should cover the same year for each.

Shore Encroachments on the Hudson River at New York City.

Another chapter in a long, tedious history has just been closed. We refer to the agitation for permission to narrow the Hudson River channel at New York City, so that certain piers can be lengthened outwardly, in order to prepare for receiving longer ocean steamships than are now in service. The International Mercantile Marine Co. made the present application for shifting the pierhead line, at its two piers in the Chelsea group[1], outward by 100 ft.; the Cunard and Cie. Générale Transatlantique lines thereupon made similar applications for their piers, and the Riparian Commission of New Jersey applied for outward shifting of the pierhead line on the New Jersey bank. During the hearing on these applications the Department of Docks & Ferries of New York City made a blanket request for outward shift of the pierhead line not only at the Chelsea piers but also north and south thereof, a distance of three or four miles. The New York Harbor Line Board (of U. S. Army engineer officers) reported adversely to these applications last week. But the matter was carried up direct to the Secretary of War. Secretary Dickinson has just granted a permit for temporary extension of the two White Star piers only.

The case is of general interest in certain respects, and the following review is therefore given.

HISTORY OF HUDSON RIVER LINES.—In spite of the long-recognized authority of the Federal government over navigable waters, the government took no action toward controlling harbor shore lines until 1888. Prior to this, State legislation and local action fixed the lines. In the case of New York harbor, the State and local authorities acted conservatively, while they were in charge, as has also the War Department since 1888; still there has always been a pronounced drift toward encroachment, as will be clearly apparent from the facts:

1855.—The New York State Legislature passed "An Act for the preservation of the harbor of New York from encroachments, and to prevent obstructions to the necessary navigation thereof." Pursuant to this act, five commissioners were appointed to recommend to the Legislature the locations of pierhead and bulkhead lines. This board requested the aid of federal experts, and therefore the U. S. authorities appointed an Advisory Council (Prof. J. G. Totten, Chief of Engineers, U. S. Army; Prof. A. D. Bache, Superintendent of the Coast & Geodetic Survey; and Commander C. H. Davis, U. S. N.). This Council reported Dec. 29, 1855, recommending locations of the lines, and recommending also that certain spaces be reserved for basins. The Board of Commissioners thereupon reported to the Legislature Jan. 8, 1856, and Jan. 29, 1857. A State law of 1857 enacted their recommendations. The result was that *the existing width of the river was materially reduced.*

Shortly thereafter, the New York authorities tried to induce New Jersey to adopt those recommendations of the Commission which referred to New Jersey lines, but the attempt failed. New Jersey in 1864 established a Riparian Commission, and this body laid down various harbor lines for the Hudson in 1865, 1872, 1875 and 1882, all of which, generally speaking, were *outward* of those recommended by the Advisory Council of 1855. The changes on the New Jersey shore were, however, at all times less marked than those on the New York shore.

1868.—The Park Commissioners of New York City, established 1868, fixed pierhead and bulkhead lines from 55th St. to Spuyten Duyvil.

1871.—The New York State Legislature authorized the Department of Docks of New York City to establish harbor lines, with the approval of the Sinking Fund Commission. The Engineer-in-Chief of the Deparement, Gen. Geo. B. McClellan, drew plans establishing new lines from Pier 1 (near the Battery) to 59th St.; thence north to Spuyten Duyvil the lines of the Park Commissioners were adopted. The McClellan plan, which was approved, shifted the pre[illegible]y accepted lines *farther out at all points.*

1888.—Congress authorized the Secreta[illegible] of War to establish harbor lines wherever [illegible]s might appear "essential to the preservation [illegible]d protection of harbors." On Oct. 5, 1888, the [illegible]w York Harbor Line Board was constituted. [illegible] thereafter it has had primary jurisdiction o[illegible] the matters now under review, always sub[illegible]t to the final action of the Secretary of War.

1890.—The Board gave general consideratio[illegible]o revision of harbor lines along the Hudson. It recommended that for New Jersey the line[illegible] of the Riparian Commission be adopted, and [illegible]r New York the lines fixed by the Dock Depart[illegible]ment in 1871, except that at this departm[illegible]'s request the pierhead line from Pier 1 to 23d St. was *moved out.* The Secretary of War appro[illegible]d these recommendations.

1897.—The Department of Docks of New York City and the Riparian Commission of New Jersey made applications for further changes of the Hudson River lines. The Board thereupon recommended changes which *shifted the lines outward,* and the Secretary of War approved the recommendations.

The present Board says of the 1897 action:

These modifications are the last which have been recommended by the Harbor Line Board, which since that date has steadily opposed any further diminution of the fairway of the river.

The successive changes of the harbor lines are summarized in the subjoined table.

However, numerous applications were made subsequently for outward shifting of the pierhead line, as follows:

1902.—Department of Docks, New York City, applied for extension of the pierhead line between Canal St. and West 30th St., the maximum shift being about 200 ft., opposite Castle Point, the narrowest section of the river. Denied Dec. 9, 1903, by Secretary of War Elihu Root.[2]

1904.—Same application repeated.[3] Denied March 31, 1904, by Secretary of War Wm. H. Taft.

1908.—Same application was again repeated. Denied July 17, 1908, by Secretary of War Luke Wright.

1910.—International Mercantile Marine Co. applied for extension of pierhead lines at its two piers in the Chelsea group, in order to lengthen the piers outward. Denied March 14, 1910, by Secretary of War J. M. Dickinson, who said: "This decision must be considered final and irrevocable."

1910.—Same application repeated Dec. 5. Subsequent applications by Cunard Line, Compagnie Générale Transatlantique, and Riparian Commission of New Jersey. This is the application just passed upon.

ADMINISTRATIVE VIEWS.—The importance of conserving adequate waterway in the lower Hudson was fully appreciated even fifty years ago. In fact the 1855 act was specifically aimed at encroachments. The Harbor Commissioners suggested to the Advisory Council some guiding considerations:

FIRST: That the preservation of free navigation of the harbor is regarded by the legislature as an object of paramount importance, and that other questions and interests are subordinate to that object.

SECOND: That it is desirable that existing structures should not be disturbed except in cases where they interfere with or are of serious detriment to navigation.

THIRD: The importance of projecting the exterior lines as far into the rivers and bay as is consistent with the free navigation of the harbor, in order that ample space may be had for the construction of docks and basins, to meet the demands of commerce.

Evidently the desire to build out as far as possible was very active even in those days, and by specific instruction this desire was given fullest consideration. Boats were smaller and slower than to-day, and the amount of river traffic undoubtedly less, therefore also the need for a wide river was less; and in spite of that the experts at that time were not willing to set the limits even as far out as the lines existing to-day. Totten, Bache and Davis were so strongly impressed with the conflict of needs that they foresaw the time when all possible pier expansion

[1]For a map of the Chelsea piers, see the inset sheet in Eng. News, Jan. 14, 1909.

[2]Eng. News, May 21, 1903, p. 441; Eng. News, Dec. 31, 1903, pp. 593 et seq., containing a brief by Samuel Whinery and a discussion thereof by the Harbor Line Board, on which the decision was based.

[3]Eng. News, Feb. 25, 1904, p. 176.

would not suffice. They said, in reporting to the Harbor Commissioners:

> Immense as this harbor is, there is a limit to its capacity and to what may be called its natural resources. The system of wet basins must be adopted sooner or later even here.

And the Harbor Commissioners in their turn made the equally significant remarks:

> It is of primary importance to the harbor that the capacity of the river as a tidal reservoir be maintained, because it is on the volume of the water returning to the ocean that we must depend to keep open the channels at Sandy Hook. * * * As respects the large portion of Thirteenth Avenue, whatever may be the private interests of the riparian owners, the necessity of cutting it off is absolute and imperative. * * * The channels, which are governed in their course by the direction of the currents, are on the easterly side of the river.

These early views, based on facts and testimony of that time, deserve to be recalled in the light of the present Harbor Line Board's statement that there are only very inadequate data on certain important phases of the subject.

It is well to bear in mind that the marginal street (West St. and Thirteenth Ave. along the Hudson) has always been an object of the Dock Department's greatest solicitude. Though the 1855 Commissioners found parts of it an encroachment, yet it is a fact that McClellan's changes of the harbor lines in 1871 were made chiefly for the purpose of giving room for

> a continuous permanent river wall so located as to widen the river street very considerably.

The interesting feature of the case is that the marginal street is concerned also in the 1902-1911 difficulties. The possibility of extending the Chelsea slips landward has always been open, and if we recall correctly was directly suggested by the Harbor Line Board in 1904. But the city authorities have refused to consider the suggestion, although at that time the difficulties of moving landward were relatively small.

RIVER CONDITIONS.—In determining on the present application, the Harbor Line Board considered hydraulic and navigation conditions, as bearing on the question whether the river may safely be made narrower. The width between pierhead lines controls in both matters, as the portions between bulkhead and pierhead are of little use for flow purposes.

Hydraulic Conditions.—The Board finds great inadequacy of data. No change in the rate of progress of the tidal wave from Governor's Island to Tivoli (16 miles below Hudson, N. Y.) can be detected since 1855, and no change in the tidal range. River cross-sections are available for two or three points above New York, for 1855-61, and for 1903-05, and their comparison shows practically no change. Two cross-sections at New York City show a slight decrease from 1855 to 1909, and one a slight increase (due to general deepening). Measurements of the maximum velocity of ebb currents at 41st St. showed 3.69 ft. per sec. in 1855, and 4.18 ft. per sec. in 1903, an increase of 13%, which in the opinion of the Board "may justly be attributed to the successive extensions of the pierhead lines."

Navigation Conditions.—Careful observations on the arrival and departure maneuvers of a number of ocean liners showed that they occupied a width of river varying from 1,100 to 1,300 ft., and required from 8 min. 20 sec. to 17 mins. for their maneuvering. The minimum width of the river is 2,730 ft.

> It would appear that the piers on both sides of the river might safely be extended, not only to the 100 ft. asked for but even a greater distance when the demand for still longer piers becomes imperative. But the width of fairway required for navigation in North River is dependent not so much upon the seagoing ships, but upon all other craft operating in this vicinity, which number in the aggregate a vast total in comparison with the relatively small number of steamships which come and go periodically.

Several vessel counts were made, to learn the precise extent of the traffic. At 23d St., during 11½ hours between 6 a. m. and 6 p. m., Feb. 17, 1911, the maximum hour's traffic was 120 vessels (5 to 6 p. m.), the minimum 76 vessels (1 to 2 p. m.), and the traffic in the hour from 11 to 12 a. m., when most of the ocean vessels depart, was 108 vessels. The total for 11½ hrs. was 1,045 vessels, giving an average of 91 vessels per hour. Several miles farther down the river, at Pier 13, the same day's count for 6 a. m. to 6 p. m. was 900 vessels northbound and 913 southbound, a total of 1,813 vessels, averaging 151 per hour. An important fact is that no excursion steamers and no up-river steamers, and few if any private pleasure vessels, run in this month, so that summer figures would be very much higher.

The Board does not believe that any reduction in river traffic is probable; indeed they state the contrary very emphatically, in expressing their final conclusion on the subject:

> That the importance of the general traffic and the number of vessels to be accommodated will increase is as certain as is the future growth of New York City, and it is no stretch of the imagination to say that it may be more than double what it now is when the population of Greater New York reaches the ten-million mark. With jealous regard for present traffic, but more particularly for the larger commerce that is certain to develop in the not distant future, the Board is of the opinion that a very grave mistake would be made in yielding any portion of the existing area of waterway between pierhead lines for the construction of piers, so long as the longest steamships can be provided with suitable wharf accommodations at other points, even though to do so will require a radical change in the system of constructing docks straight out from the shore, which has been in vogue up to the present time.

The fact is that the policy of building piers at right angles to the shore line, on the shortest distance between bulkhead and pierhead lines, was definitely adopted by the Department of Docks of New York City in 1871. The Harbor Line Board says:

> The subsequent extensions of the pierhead lines as well as the subsequent applications for extensions have all been caused by this policy, under which the maximum distance between the pierhead and bulkhead lines establishes a limit of the length of ships which can make use of the piers.

The Harbor Line Board considered the claim which has been made that no other place is available for docking ships longer than 800 ft. in New York harbor, or at least no other place as convenient. It finds that several other points are available for such docking, and these can be made ready even within the four months remaining up to the time of the expected arrival of the 882½-ft. "Olympic" (June or July, 1911). Moreover, the Board finds that other places would be fully as convenient, and that the Chelsea location is *not* the nearest to the center of the hotel district as claimed.

A significant passage in the Board's report throws light on the attitude of the Dock Department and the transatlantic lines toward the alleged docking difficulties. It states that the Chelsea piers were *designed after* the possibility of the advent of larger vessels was known. The Dock Department knew that 1,000-ft. piers might be needed. Despite this fact and despite the War Department's action on the 1902 application,

> the Chelsea piers were designed and constructed for the very companies which anticipated the necessity for the larger ships. These piers were first occupied in February, 1910, *after the keel of at least one of the new vessels had been laid.* Up to the present time it would appear that with the exception of making requests on the War Department to extend the pierhead line, *no effort has been made to provide accommodations* suitable for the vessels then under construction.

The facts so stated inspire a strong suspicion that the steamship officials, as well as the officials of the New York Department of Docks, have throughout the past seven years relied confidently on the ultimate success of their application for the permit for pier extension.

The Board found that the only new conditions since the rejection of the last previous application is the discontinuance of the Pennsylvania R. R. ferry to 23d St., and that this change does not warrant a modification of the War Department's decision. The Board consists of Col. Wm. T. Rossell, Col. W. M. Black, and Col. S. W. Roessler.

Its report was transmitted to Washington last week. Agitation of very extensive proportions was at once started to induce Secretary-of-War Dickinson to overrule the Board. Vice-President J. S. Sherman, Governor J. A. Dix, and Mayor W. J. Gaynor separately urged Secretary Dickinson to give a personal hearing on the matter and prevent the "destruction of the magnificent commerce of the port."

As a result, the Secretary arranged a hearing on March 6, which was attended by a large delegation of interested parties from New York. At this hearing the request was re-stated by an official of the International Mercantile Marine Co., with the vital modification, however, that only *temporary* extension was asked for. On this statement Secretary Dickinson at once granted the request, announcing at the same time that he would make the terms of the permit very strict.

Before this hearing, the governor of New York announced that he would appoint a committee to act with a similar body from New Jersey and with a board of the War Department, for the purpose of considering the development of the port and the changes desirable in harbor lines, etc., to provide for the future needs of commerce.

FROZEN CONCRETE as a rule cannot be detected by ordinary inspection from concrete cured under natural conditions. Cutting out a chunk, placing it on a hot stove and seeing whether it sweats and softens up is the only reliable guide to determine whether the concrete has been merely stiffened up by frost or has actually cured to an extent which would warrant us in trusting its strength.—C. A. P. Turner, M. Am. Soc. C. E., in address before the Canadian National Association of Builders' Exchanges, Feb. 16, 1911.

TABLE OF CHANGES IN HUDSON RIVER HARBOR LINES, NEW YORK CITY, SHOWING PROGRESSIVE DIMINUTION OF RIVER WIDTH.
(From Report of New York Harbor Line Board.)

BHL = Bulkhead line. PHL = Pierhead line. Distances outward, in feet. Where inward, marked minus (—).

LOCATION	Advisory Council to New York Harbor Com'rs 1855, confirmed by N. Y. Leg. 1857.			Riparian Commission of N. J. 1865—1882.			Dept. of Docks and Sinking Fund Comm., N. Y. City 1871.			N. Y. Harbor Line Board, confirmed by Sec'y of War, 1890.			N. Y. Harbor Line Board, confirmed by Sec'y of War 1897.		
	BHL.	PHL.	Fairway	BHL.	PHL.	Fairway	BHL.	PHL.	Fairway	BHL.	PHL.	Fairway	BHL.	PHL.	Fairway
	Ref. to shore line of 1767 map.		ft.	Ref. to lines recom. by Adv. Council 1855.		ft.	Referred to lines of 1855.		ft.	Referred to lines of 1871.		ft.	Referred to lines of 1890.		ft.
NEW YORK SHORE:															
Battery Place	380	1,125	3,980	...	...	3,980	120	90	3,890	...	...	3,890	...	...	3,890
Desbrosses St.	500	1,040	4,180	...	...	4,020	110	110	3,910	...	160	3,750	...	120	3,530
West 11th St.	*240	800	3,840	...	...	3,000	370	‡40	3,560	...	160	3,400	...	100	3,110
West 14th St.	960	960	3,200	...	...	3,000	100	100	2,900	...	50	2,850	...	80	2,770
West 23d St.	1,485	1,760	3,650	...	...	3,000	100	270	2,730	...	...	2,730	...	...	2,730
West 30th St.	1,300	1,600	3,800	...	...	3,240	30	250	2,980	...	...	2,980	...	85	2,895
West 55th St.	420	720	3,400	...	...	3,400	30	240	3,160	...	...	3,160	...	190	2,770
West 61st St.	700	1,000	3,340	...	...	3,340	30	230	3,140	...	...	3,140	...	200	2,740
West 72d St.	300	600	3,200	...	...	3,320	105	200	3,120	...	...	3,120	...	130	2,790
NEW JERSEY SHORE:															
Communipaw Ferry	...	...	3,980	...	...	...	...	...	...	...	...	...	...	...	...
Pavonia Ferry	†1,800	†2,300	4,180	—85	140	...	...	...	...	...	...	...	...	100	...
Hoboken Ferry	†450	†950	3,870	180	200	...	...	...	...	...	...	...	...	190	...
Castle Point	...	...	3,200	...	200	...	...	...	...	...	...	...	...	...	...
N. Y., L. E. & W. Docks	†600	†920	3,800	400	500	...	...	...	...	...	...	...	...	...	...
West Shore R. R.	†500	†1,170	3,400	320	...	...	...	...	...	...	...	...	...	200	...
Guttenburg	†100	†680	3,200	140	—110	...	...	...	...	...	...	...	...	200	...

*No bulkhead line recommended between 11th and 14th Sts.
†Recommended by Advisory Council, N. Y. Harbor Commissioners, but not adopted by New Jersey.
‡No piers proposed by Gen. McClellan between 11th and 18th Sts.

The Slow Sand Water-Filtration Plant at Toronto, Ont.

By FRANCIS F. LONGLEY,* Assoc. M. Am. Soc. C. E.

There is in course of construction in the city of Toronto a slow sand water-filtration plant, under the direction of C. H. Rust, City Engineer.

The city of Toronto lies on the north shore of Lake Ontario not far from the western end. Along the front of the city there lies a long, low island composed entirely of lake sand and gravel which has been built up presumably by the action of the lake currents carrying this material from high lands facing the lake several miles east of the city. Immediately in front of the city the outer edge of this island is somewhat more than

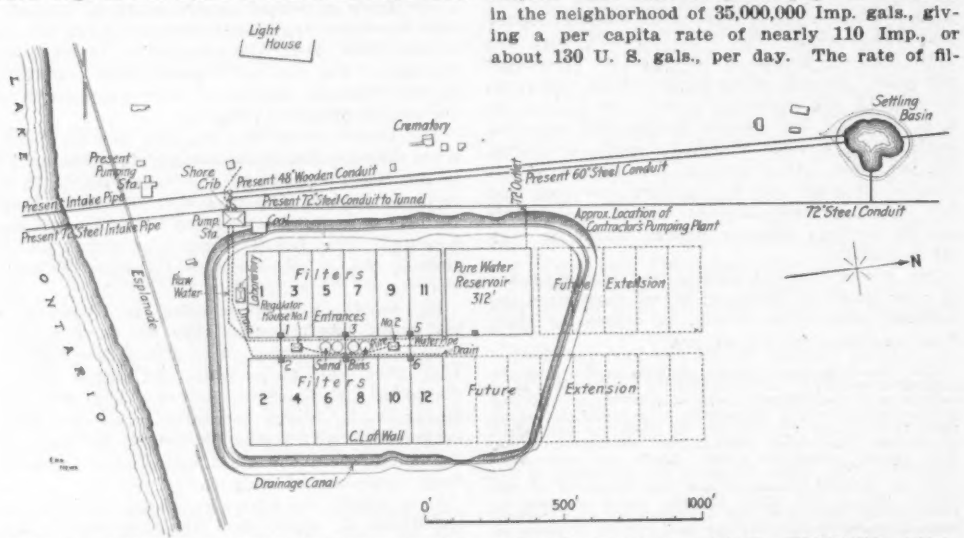

FIG. 1. GENERAL LAYOUT OF SLOW SAND WATER-FILTRATION PLANT, TORONTO, ONT.

two miles from the city waterfront. The island has no very great width and at the back is much cut up into lagoons which, together with the bay, form a large body of water into which much of the sewage of the city is discharged. There are outlets or channels from the bay into the open lake at the extreme western end of the island and towards the eastern end.

The intake of the city water-supply lies in some 50 ft. of water about half a mile south of the southernmost point of this island. From the intake a 6-ft. steel pipe runs to the shore of the island, thence across to the bay, there dropping into a tunnel in rock which passes under the bay directly to the main pumping station of the water-works system at the foot of John St. The natural lake currents and the wind movements carry to the intake the polluted waters of the bay and also a large quantity of sewage which empties into the open lake outside the bay. This condition has been recognized for some years and the logical remedy which has been repeatedly recommended and which is now being carried out is the purification of the supply.

The monthly average bacterial counts in recent years have generally been a few hundred per cubic centimeter. Monthly averages of 500 per cc., however, have not been uncommon. Double this number has been reached on several occasions and the maximum recorded content has been about 16,500 per cc. Periodical examinations have been made during recent years for the presence of the colon bacillus in the water-supply and in samples of 1 cc. it has been found present in from 7% to 48% of the total number of samples examined each month, averaging about 25%.

Typhoid fever has never been very severe in Toronto but there have been a number of occasions when it has been unusually prevalent in the city, when the blame for the high typhoid rate seemed clearly due to some irregularities in the water-supply which permitted the entrance into the pipes of polluted water from the bay.

The city is also carrying out a comprehensive scheme of sewerage, including high-level and low-level interceptors and sewage tanks, the effluent of which will be discharged through a submarine pipe into the open lake off the south shore of the island, some five miles east of the intake of the water-supply. The decision to construct the water-filtration plant was, of course, influenced by this fact. Upon the recommendation of the Provincial Board of Health, and as a result of the action of certain public-spirited members of the medical fraternity, an appropriation for filters was made two years ago. Mr. Allen Hazen was retained as Consulting Engineer and tenders were opened for the work on May 18, 1909. Since that date the writer has been in active charge of the construction work.

The population of the city of Toronto is about 325,000. The total daily dumpage of water is in the neighborhood of 35,000,000 Imp. gals., giving a per capita rate of nearly 110 Imp., or about 130 U. S. gals., per day. The rate of filtration assumed in the design of the plant was 5,000,000 Imp. gals., or 6,000,000 U. S. gals. per acre per day. This rate is somewhat higher than the conservative rate assumed for design ten years ago, more or less, but considerable experimental work and actual experience upon relatively clear lake waters, such as that of Lake Ontario, gives ample justification for the use of that rate. To avoid interference with the existing hydraulic conditions in the intake pipe and tunnel, a low-lift pumping station was designed as an essential part of the plant to give the water the necessary lift to overcome the friction through the filters and piping. The pump-well which forms the substructure of this pumping station is built immediately adjoining a steel crib structure on the 6-ft. intake pipe on the island, some five or six hundred feet from the lake shore. From this pumping station a concrete pipe-line runs through the central court with branches each way serving as distributors for the unfiltered water to the several filters. The filters are laid out in two rows of six filters on each side of the central court. The effluent pipes from the filters run to two regulator houses in the central court and from these regulator houses another large concrete pipe-line carries the filtered water to the pure-water reservoir, which has a capacity of 7,500,000 Imp. gals. A short line of 2-in. concrete pipe connects the pure-water reservoir with the 6-ft. steel pipe line crossing the island somewhat more than 1,000 ft. from the crib structure referred to above, adjoining which the pumping station was built. When the plant is completed and in service, this thousand feet of existing intake pipe will thus be by-passed.

The water will be lifted at the pumping station to the level of the filters, which is naturally somewhat above lake level, and will flow through the filters and other structures into the pure-water reservoir and thence into the existing 6-ft. steel pipe again, at an elevation which will give perfectly satisfactory conditions for the operation of the pumps at the main pumping station in the city. The arrangement of the plant and the other general features is shown in the accompanying plan (Fig. 1).

LAND-DRAINAGE ARRANGEMENTS.—The question of the drainage of the work during construction was a large one as the floors of the filters and the pure-water reservoir, and consequently many other structures, were placed below the level of water in the lake. The sandy nature of the site increased the apparent difficulties of this problem. To give perfect drainage to the site a channel (Figs. 1 and 2) having a total length of some 4,000 ft. or more, was dredged entirely around the work. Dikes were built at three points where the old lagoons cross the channel, thus entirely enclosing the drainage canal. At a convenient point a pumping plant was erected, consisting of two 12-in. centrifugal pumps direct-connected to vertical steam engines, each having a rated capacity of 4,000 Imp. gals. per min. against a lift of 10 ft. In order to avoid exorbitant prices on this drainage work, due to lack of information on the part of bidders as to the quantity of water that would have to be pumped from the canal, the city guaranteed the maximum rate of pumping that would be required in order to keep the water down to the desired level in the canal, the contract stating in substance that in case the two pumps, one being operated all the time and the other for half the time, were unable to hold the water down, the engineer might require other and larger pumps to be provided, in which case the city would stand the extra cost thereof.

The price bid by the successful contractor for this drainage work complete, including the dredging of the canal, the maintenance of the pumps, the refilling of certain portions of the canal, together with the local drainage that was required at a number of points both within and without the drainage canal, was equivalent to somewhat less than 4% of the total estimated cost of the

FIG. 2. DREDGING THE DRAINAGE CANAL AROUND THE SITE OF THE TORONTO WATER-FILTRATION PLANT.

*Resident Engineer, Filtration Plant, care of City Engineer, Toronto, Ont.

work. The following facts relating to the drainage of the work are interesting in this connection. The inflow into the canal was estimated, at the time that the specifications were written, from the best data at hand and a generous factor of safety allowed in setting the guaranteed limit of quantity referred to above. Subsequently the writer found in certain old reports of the City Engineer's Department of Toronto a record of a construction and certain tests thereon that formed an interesting parallel to this drainage canal. Some thirty years ago or more, the city, which was at that time using water from the bay, attempted to get a more satisfactory supply by digging a filtering basin along the shore of the lake, close to the site of the present filtration plant. The filtering basin had a perimeter of about 6,340 ft. and a depth of about 14 ft. below lake level. After it was completed a number of pumping tests were made to determine its capacity. A summary of these tests is shown in Table I. The perimeter of our present drainage canal is about 4,100 ft. If the conditions surrounding this present canal were the same as those surrounding the old filtering basin, we might therefore expect to get an inflow in this canal corresponding to the inflow shown by these old tests and reduced in the ratio of 4,100 to 6,340. The last column in the table is computed from the column before it, to show this probable inflow in the present drainage canal, as determined from the results of these old tests.

TABLE I.—RATE OF INFLOW INTO OLD FILTER BASIN AND ESTIMATE INFLOW INTO DRAINAGE CANAL, TORONTO, ONT.

Test No.	Range of depth below lake level, ft.	Inflow, million Imp. gals. per day. Old basin.	1909 canal.*
1	8.0 to 8.3	4.66	3.02
2	8.0 to 8.4	3.86	2.50
3	7.7 to 8.4	4.54	2.94
4	7.8 to 7.9	3.54	2.29
5	7.9	3.42	2.21
6	7.3 to 7.5	3.90	2.52
7	8.5 to 8.7	4.60	2.98
8	8.1 to 8.3	4.39	2.84
9	8.4 to 8.7	4.84	3.13
10	8.0	4.43	2.87
11	8.0 to 8.4	4.39	2.84
12	8.3	4.74	3.07
13	8.5	4.51	2.92

*Assuming same conditions as governed old basins.

A basin and weir were constructed near the drainage-canal pumping station in order to measure the quantity of water pumped therefrom. Observations have been taken at the weir systematically during parts of the time, although certain irregularities have made it difficult to get satisfactory results at all times of total daily quantities. Table II. gives a summary of the monthly periods during which the conditions most favored reasonable accuracy in determining the total quantities pumped from the canal.

TABLE II.—MONTHLY RATES OF DRAINAGE CANAL INFLOW.

Month.	Average depth below lake level ft.	Rate of inflow, million Imp. gals. daily. Actual.	Reduced to 4,100 lin. ft. basis.
1910 March	6.7	1.60	1.60
April	7.0	1.60	1.60
May	7.4	2.20	2.20
June	7.5	2.00	2.00
July	7.3	2.20	2.20
December	5.8	1.12	1.48
1911 January	5.7	.86	1.14

Assuming that the flow of water through sand under such conditions as pertain here varies with the first power of the head, the results of the old tests of the filtering basin would indicate an inflow into the canal of about 2,400,000 Imp. gals. per day for a difference in levels of 7 ft. between the lake and the water in the canal, or .41 Imp. gals. per lin. ft. per min. The results of the measurement of water at the weir on the present drainage canal indicate an inflow for 7 ft. difference in level of about 1,800,000 Imp. gals. per day, or .31 Imp. gals. per lin. ft. per min. There are certain interfering factors that tend to account for this difference between the tests of 1877 and the present measurements, chief among which is the fact that the old filter basin lay only 155 ft. from the shore of the lake and the slope of the water passing through the sand and entering the basin was therefore much greater than the slope at which the ground water stands at present about our drainage canal.

We have observed the ground-water level at a number of points outside our drainage canal with average results as follows:

First 100 ft. from canal, ground-water slope = 2.6%.

200 ft. beyond, = 1.5%.

It must be recognized, of course, that this slope will vary widely with varying conditions of porosity, etc., but our observations indicate that, for the entire fall, the slope of the ground water will probably not exceed 2%. During the old tests on the filtering basin the difference in level between the lake and the water in the basin average about 8 ft. for a horizontal distance of 155 ft. The slope would therefore be something over 5%. Obviously this would induce a much greater flow into the old basin than under existing conditions into our drainage canal. Some 2,700 ft. of the old filter basin was influenced by this condition just described.

Although the quantity of water flowing into the canal is actually much less just now than at first, giving the impression that the rate of inflow is diminishing, if we consider the changes in level and the fact that about 1,000 ft. of the canal is now ineffective, due to refilling at certain points, there is no consistent evidence to show a diminution in the rate of flow.

It is interesting to note here that the old filter basin was a disappointment to the city on account of its small capacity as well as on account of the great quantity of iron that is found in the water drawn thus from the sand. This basin was abandoned entirely after certain efforts to increase its capacity and was subsequently filled up again.

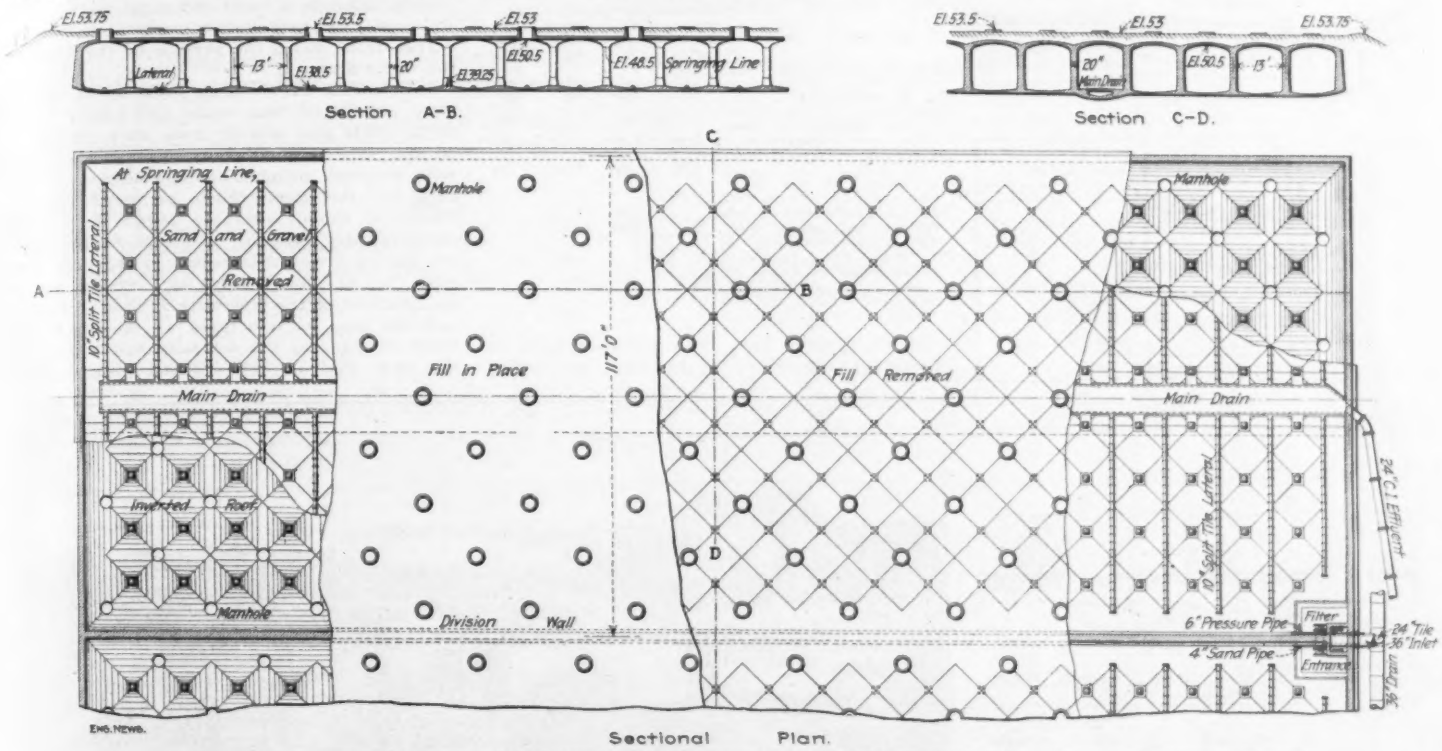

FIG. 3. MULTI-SECTIONAL PLAN AND VERTICAL SECTIONS OF A FILTER, TORONTO WATER-FILTRATION PLANT.

EXCAVATION AND FILL.—The total quantity of excavation on the work, including the dredging of the drainage canal, amounted to approximately 150,000 cu. yds. The excavation of the drainage canal was done by means of a bucket dredge which placed the excavated material on the banks of the canal convenient for refilling, as certain portions of the canal have to be filled in again and graded up to the general grade of the filters. Most of the filter and reservoir excavation was done by means of slip scrapers and wheel scrapers and moved direct to the spoil banks. A considerable part, however, was dumped from the scrapers through a trap into cars and these cars hauled across the site and dumped for fill on the top of the finished filter masonry. It is proposed to put 6 ins. of clay fill or other soil suitable for top surface over the entire plant and put it down in grass. Embankments will be sodded.

FILTER MASONRY.—Four classes of concrete masonry have been used in construction, as shown in Table III. The concrete filling was used under certain foundations, around vitrified pipe and in a few other places. The special concrete was used for the sand bins, sand washer foundations, reinforced slabs for manhole covers and superstructures for the buildings, etc. The filter masonry concrete was used in all the floors, walls, piers and vaulting in the filter construction and constituted more than 95% of all the masonry. The other class of concrete was used for all reinforced-concrete pipes, the Ven-

turi meter and the monolithic bends and connections on the concrete pipe-lines.

The cement used has been entirely of one brand, Canadian Lehigh. This cement was brought in barges from the mill to Toronto, unloaded in the bay onto the contractor's scows and towed right to the work, where it was delivered into a cement shed located on the contractor's wharf. The cement was always sampled as it was unloaded. One mixed sample was taken from each 100 bbls. of cement, taking a portion of this mixed sample from about one sack out of twenty. The specifications for cement were substantially those adopted by the American Society for Testing Materials. These samples were taken directly to the city laboratory, already established before this work commenced, and tested there. The cement has been uniformly good and none has been rejected out of more than 35,000 bbls. delivered on the work to date.

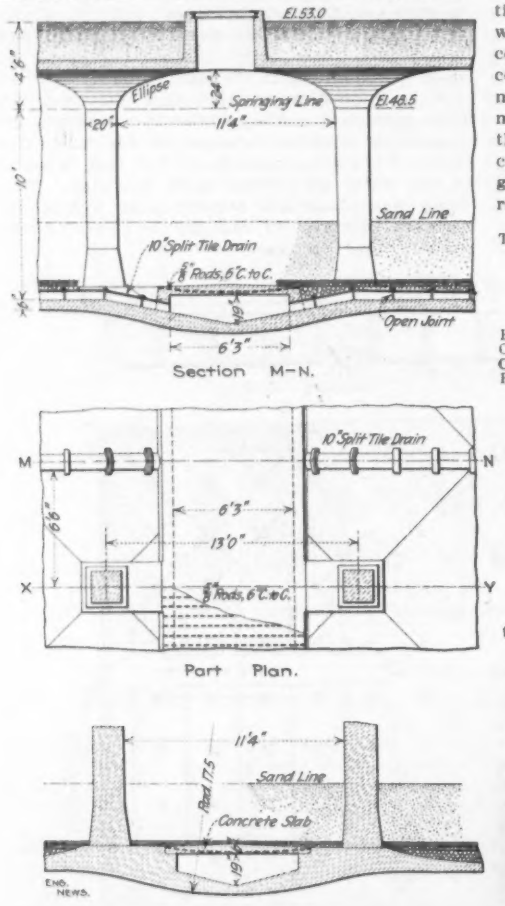

Fig. 4. Details of Main Drain, Toronto Water Filters.

The other concrete materials, sand and gravel, have been obtained in large part on, or near, the site. The work is only a few hundred feet from the shore of Lake Ontario and there was of course much gravel on the beach. The contractor erected a dredging and screening plant at that point and obtained a fine quality of gravel for the concrete, and of course large quantities of excellent sand. The plant, however, has never been capable of producing the quantity of gravel required to maintain the required rate of progress on the work and the contractor has, from time to time, brought in considerable quantities of gravel and crushed stone from the outside. Both the gravel and sand obtained from the beach have been naturally graded through a wide range of sizes. There has been some material in the gravel that might properly be classed as sand, and some in the sand that might, if separated, be classed as gravel, and consequently the percentage of voids has been low in both. This has made the quantity of cement per cubic yard of concrete rather low, considering the richness of the mixture, as indicated in Table No. III., but it has given a concrete of excellent quality and apparently of good density and watertightness throughout.

For the guidance of contractors in bidding on the work, a conservative estimate was made in the specifications of the quantity of cement that would be required per cubic yard of concrete of the various grades. From certain experimental data obtained during the early part of the work, and confirmed by later study, another computation was made of the quantity of cement that would probably be required per cubic yard of concrete. The office records of concrete placed, cement actually used, etc., have been summarized, too, and the actual quantities of cement used per cubic yard of concrete computed therefrom. Table III. gives the proportions specified for the various grades of concrete, together with a summary of the information just referred to.

TABLE III.—PROPORTIONS EMPLOYED FOR FOUR CLASSES OF CONCRETE.

Materials.	Concrete pipe, meter, etc.	Special concrete.	Filter masonry concrete.	Concrete for filling.
Bbls. cement, @ 350 lbs....	1	1	1	1
Cu. ft. sand.....	7	7	9	13
Cu. ft. ballast.....	10	12	16	24
Bbls. cement per cu. yd. concrete estimated in specifications (conservative)..	2.06	1.90	1.45	1.00
Computed from experimental data.....	1.87	1.69	1.30	.90
Actually used in:				
Concrete pipe, 838 cu. yds..	1.93	....	....	....
Sand-bin walls, 411 cu. yds.	....	1.70	....	....
Office bldg., 293 cu. yds..	....	1.70	....	....
Pure-water reservoir, 2,-189 cu. yds.....	....	....	1.28	....
Filter masonry, 10,130 cu. yds.	....	....	1.31	....
Regulator house, 52 cu. yds.	....	....	1.38	....

The filter floors have been placed directly on the sand as excavated. Pains have been taken to avoid carrying the excavation at any point below the grade of the floors and the precaution was always taken to wet and compact the exposed sand surface just before placing each floor block. The sand throughout the island is very calcareous in its nature and seems to pack better than silicious sand. So far we have had no evidences of appreciable settlement at any point, although none of the structures have yet been filled with water. The floor blocks, which are of the inverted groined-arch type commonly used, and which are shown in the accompanying drawing of a single filter (Fig. 3) have been placed in alternate sections, the intermediate sections being laid afterwards and screeded to the first ones laid. The wall blocks have been placed in alternate sections in lengths of 13 ft., with dovetailed joints tarred between each two sections. The electric conduits for lighting in the filters, and the fixed angle-iron supports for the 4 and 5-in. sand piping system, have been placed in the walls as they were filled. The groined-arch vaulting was placed as is usual, in alternate sections, and the manholes were placed monolithic with the last adjoining section of the roof vaulting. Wooden forms were used for the filter masonry with the exception of the manholes, which were placed in forms of light sheet steel. The concrete pipe, too, were all cast in sheet-steel forms.

Attention is called to the main drain of the filter, a detail of which is shown in the accompanying drawing (Fig 4). This drain is formed by a depressed section of the concrete floor and a cover slab of reinforced concrete is placed across the top of the low sidewall of the drain. The reinforced-concrete cover slab is made to fill in completely the space between the two pier foundations upon either side of the drain in order that there may be no lack of continuity in the arch action at that point to resist the vertical thrust. The substructures of the entrance houses for the filters are built up monolithic with the adjoining filter walls. These entrance houses contain the sluice gates for controlling the flow of unfiltered water to the filters, and also the gate valves controlling the discharge from above the surface of the filters to the waste drain.

CONCRETE PIPE.—Some 3,300 lin. ft. of concrete pipe have been made and placed in the work. This pipe was of three sizes, 72, 54 and 36 ins. The original plans upon which tenders were received included detailed designs for this pipe, but the specifications permitted the contractor to submit alternate designs for the approval of the engineer. The pipe finally chosen for the work was the product of the Lock Joint Pipe Co., of New York City. Forms for the manufacture of the pipe were shipped to Toronto and the pipe manufactured at the site of the filtration plant by the company just named (see the view, Fig. 5). The 72 and 54-in. concrete

FIG. 5. MAKING REINFORCED-CONCRETE PIPE FOR THE TORONTO WATER-FILTRATION PLANT.

pipe were used for the main raw-water distributor between the pumping station and the filters and also for part of the filtered-water carrier. The 36-in. pipe was used for the main waste drain and for branches to the filters from the main raw-water distributor. Unusual precautions were taken in the design of these pipe and in the specifications for their construction to obtain water-tightness. Each length of pipe was laid in the trench, fitted to the lengths already laid and brought to line and grade supported on wooden blocking. The bell and spigot ends of the pipe are designed so that the inside joint has a dovetailed shape, and this dovetail is finally to be filled with cement mortar. There is almost certain to be some settlement of the pipe-lines when they are loaded with water, and if the inside mortar joints were made before this settlement occurred there would unquestionably be many cracks and leaks. This we hope to avoid as much as possible by leaving the inside joints open until such time as the pipe-lines can be filled with water and allowed to settle as nearly as possible to their final positions. With

this end in view a temporary joint is made on the outside of the joint as follows: The joint is first calked from the outside with oakum. The outside surface of the pipe for several inches each side of the joint is then coated with hot tar and covered with alternate layers of building paper and hot tar and finally with a strip of burlap bound with iron wire twisted tightly into position, one each side of the joint. After some little experience with this joint it was found advantageous to soak the oakum used in calking the joints in melted tallow. After these outside joints had been completed the trenches were backfilled.

All but a few feet of the concrete pipe has been placed and the trenches filled as just described. Part of the pipe-lines have already been completely submerged in water and have presumably settled nearly as much as they are going to settle. The inside joint work is now proceeding satisfactorily in these sections. The other pipe-lines which have not been submerged cannot have their inside joints completed until later. It is evident that the tightness in the outside joint is a most important matter in facilitating the finishing of the inside joints, as much of the inside work is likely to be done with a considerable head of water on the outside of the pipe.

In order to avoid breakage due to the unequal settlement that so often occurs where a pipe-line enters a massive structure much less liable to movement, a vertical joint was provided in the concrete pipe immediately outside of every masonry structure that the pipe enters. Short sections of concrete pipe, designated as stubs, were cast, having a laying length of 13 ins. Where the concrete pipe-line is to enter a masonry structure one of these stubs is built solidly into the masonry with the bell or spigot projecting and the pipe-line is laid from this stub, thus providing a plane of cleavage within a few inches of the larger structure.

The larger-sized pipe were handled by means of a crane running on tracks alongside the trench. Each section of the 72-in. pipe weighed about 4½ tons. For the 36-in. pipe a small steel framework running on wheels and supporting a beam with a differential block and tackle rolling upon it has been used. The pipe is rolled out onto planking over the trench and is then lifted by the tackle, the planking removed and the pipe lowered to its place.

The manholes on the various pipe-lines are built up of lengths of 36-in. pipe set vertically upon the top of the monolithic structure on the pipe-line itself. These vertical sections are surmounted at the right height by reinforced-concrete reducers which were cast in the same manner as the pipe and upon the top of these are placed the cast-iron manhole frames. The masonry structures forming the bottom of the manholes and the bends and connections between two or more pipe-lines have been built as monolithic concrete structures.

FILTERING MATERIALS.—The filtering material is to consist of 12 ins. of crushed stone or gravel, in three layers of graded sizes, and 3½ ft. of sand. Practically none of this material has yet been placed in the filters, although a number of the filters are now (Feb. 21, 1911) ready to receive it. Owing to the difficulty in getting an adequate supply of gravel on the island for the large quantity of concrete, it is probable that we will use crushed stone instead of gravel in the bottom of the filters. Stock for filter sand may be obtained in practically unlimited quantities at any point on the island. The examination of a large number of samples of sand taken at various points on the island indicated that the quality of the stock is such that we might expect a theoretical yield of 85% or 90% which would lie within the limits of the specifications. Practically speaking, however, the stock will probably yield a considerably lower percentage of filter sand than that. The stock contains a considerable percentage of very fine sand, the average effective size of a large number of samples being .21 mm. The specifications call for an effective size of 25 to 35 mm., and a uniformity coefficient not greater than 3. The contractor is now at work on a plant for preparing this filter sand to be ready to operate as soon as spring opens up.

The essential features of this plant are, first, a hydraulic dredge with a 15-in. pump and a probable capacity of 100 cu. yds. of stock per hour; second, a large trough into which the dredge will discharge and which is intended to act as a crude classifier depositing first gravel and then sand of continually-diminishing size as the flow progresses through the trough; the water, together with much of the finest sand, wasting at an overflow. The trough thus serves also as an unwatering device to dispose of the large quantities of water which carry the sand stock from the dredge to the separator. The gravelly portion of the deposit in this trough is then to be continuously removed by means of an elevating device and discharged upon screens, where it will be graded for filter gravel or stored for concrete ballast. The sand will be removed continuously from a number of points along the length of this trough, the discharge from each point being carried to the final sand washer in such a way that the sand from one or more of these sections can be wasted if it is found to contain an excessive quantity of fine material. The sand-washer box, which is the final step in the preparation of the sand, is of the type that has been used in a number of places, notably in Washington, D. C., and described in connection with various papers on that and other plants (see Eng. News, Nov. 8, 1906, for description Washington filters).

PIPING AND GENERAL ARRANGEMENTS.—From the front walls of the filters the filtered water will flow through 24-in. cast-iron effluent pipes with a Venturi meter upon each line discharging into the substructures of the two regulator houses (Fig. 6). Each regulator house serves six filters. In the regulator house there is a separate compartment for each filter effluent with the necessary gates for controlling the rate of filtration, the backfilling of the filter and the flow into the central compartment from which a concrete pipe-line runs out to the pure-water reservoir. In each regulator house there are two

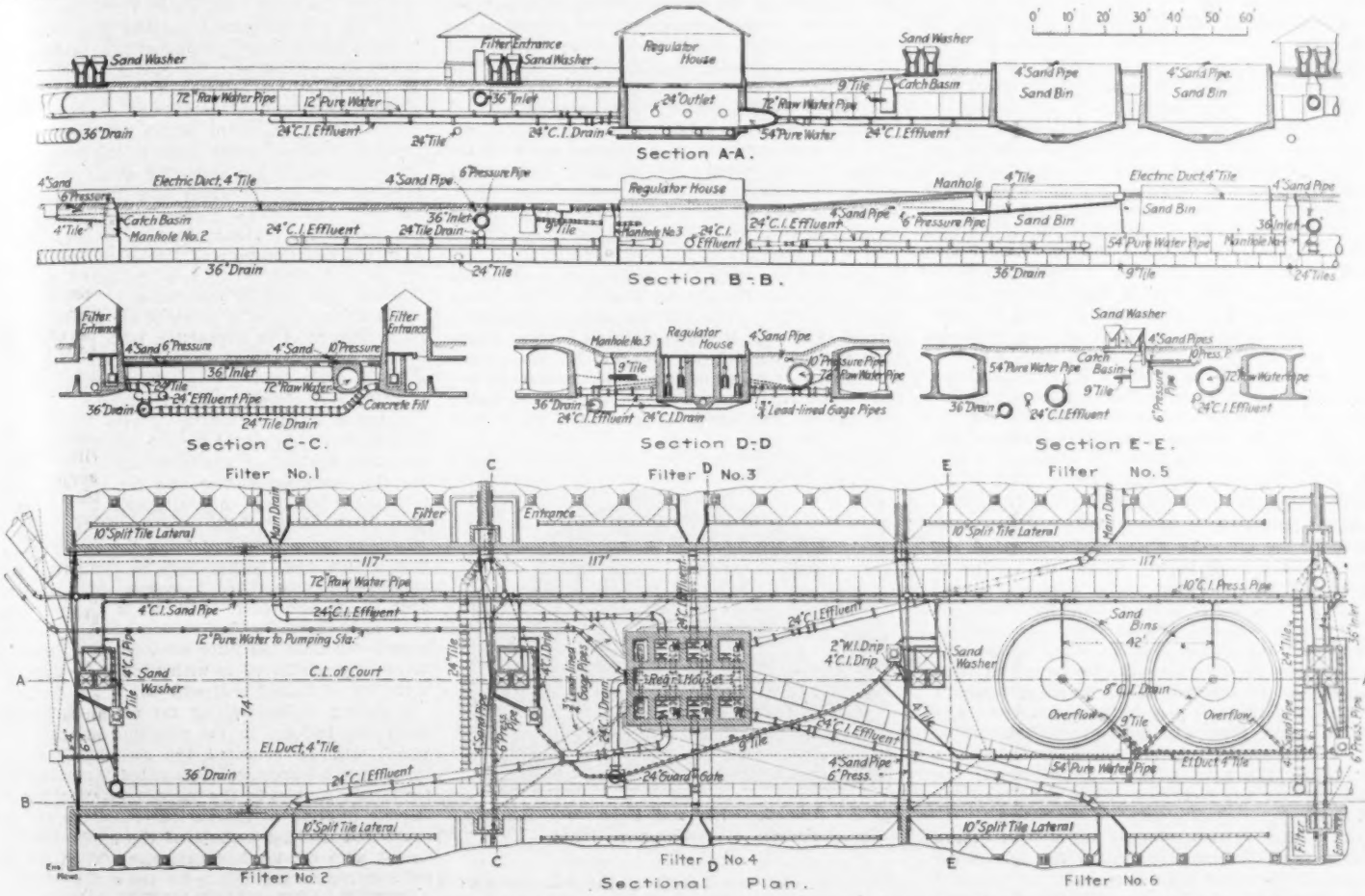

FIG. 6. PLAN AND DETAILS OF MAIN PIPE SYSTEM, REGULATOR HOUSE AND SAND BINS, TORONTO WATER-FILTRATION PLANT.

small compartments for dry wells in which are located the float pipes connected with the Venturi meters. A complete drainage system is provided in the massive concrete floor of each regulator house. A line of 54-in. concrete pipe serves as carrier for filtered water from the first to the second regulator house and a 72-in. concrete pipeline from the second regulator house to the pure-water reservoir. This reservoir is similar in construction to the filters except that it has a greater depth. There is no controlling device of any kind upon the flow of water through the reservoir. The water will flow to it freely from the filters and the flow from it will depend upon the rate of pumping at the main pumping station in the city.

A complete system of drainage is provided for the plant. This consists of a main drain of 36-in. concrete pipe, already referred to, with 24-in. branches of vitrified tile entirely surrounded with concrete from the several filter entrances, and numerous smaller connections with catch basins, sand bins, sand washers, electric-duct manholes, etc. The 36-in. main drain is laid through the central court and into a drainage well in the pumping station, and thence to a lagoon.

The relative levels of the filters and of the lake are such that the drainage can be effected only part of the time by gravity. At other times the flow in this drain must be lifted a few feet to discharge above lake level. Two gate arrangements are therefore provided in this drainage well: one, a 36-in. circular sluice gate, which is open when conditions permit a gravity discharge, and the other a 16-in. by-pass discharging into the outflow portion of this drain beyond the 36-in. sluice gate through which the drainage flow is discharged when necessary by means of a low-lift centrifugal pump. The general plan of the court shows the typical arrangement of piping.

SAND-HANDLING EQUIPMENT.—The equipment for cleaning the filters and recovering and restoring the sand to the filters will consist in general of the following parts: a piping system to carry water under pressure into the filters and to the sand washers and to carry the slush of sand and water in the ejecting and washing processes from the filters to the washers and from the washers to the sand bins; centrifugal pumps in duplicate in the pumping station for supplying water for this purpose; movable ejectors of suitable design for ejecting the dirty sand from the filters; the sand washers in the court; the sand bins for the storage of clean sand, and the appliances for replacing sand in the filters.

The piping system consists of a 10-in. main leading from the pumping station throughout the length of the court with 6-in. branches opposite each filter wall, passing through the front wall and continuing as a 5-in. wrought-iron pressure line along the side walls of the filters, and with other branches leading to the sand washers. Also a 4-in. wrought-iron pipe-line along the side walls of each filter, passing through the front wall as a 4-in. cast-iron line which leads directly to the washers and from the washer leads to the discharge into the sand bins.

The movable ejectors are of the type which has been used successfully at a number of other plants; consisting of a rectangular box of steel with the ejector and irrigating pipes in the bottom of the box and the box provided with two hose connections, one for the supply of water under pressure to the nozzle, the other for the discharge to the sand pipe along the filter wall.

The sand washers are in principle similar to the ones in use at Washington and Springfield; consisting briefly of reinforced-concrete hoppers into which the slush of dirty sand and water from the filters is discharged. A jet of water subject to adjustment is admitted into each of these hoppers at the bottom, causing a vertical velocity of water in the hopper which is designed to carry the dirty water away at the overflow while still permitting the scrubbed sand to fall freely into the bottom of the hopper where it is picked up by an ejector and carried forward to the sand storage bins. There are two of these hoppers in each sand washer and the sand goes through them successively for the sake of thoroughness in cleaning. The overflow from these two hoppers goes into another large hopper, also of reinforced concrete, which serves as a catch basin to recover the fine sand which always goes over in considerable quantities from the washer hoppers and further prevents this from going into and clogging up the drainage system. An overflow the full length of this hopper carries the dirty water, now entirely free of sand, away to the sewers. A small ejector is provided in the bottom of this hopper by means of which the sand that accumulates therein may be discharged from time to time back into the washer.

The ejectors, both in the sand washers and in the portable ejector boxes in the filters, have been designed in accordance with the principles that have been studied during the last few years by Mr. Hazen and the writer. These principles are summarized and presented by Mr. Hazen in the "American Civil Engineer's Pocket Book" and at somewhat greater length by Mr. Hazen and the writer in certain current discussions before the New England Water Works Association.

The sand-storage bins are four circular tanks of reinforced concrete, the bottoms being in the shape of an inverted cone. Each of these tanks has a diameter of 34 ft. and a depth of 16½ ft. above the base of the cone and has a capacity of about 600 cu. yds. The conical bottoms of the bins were placed first and included complete arrangements of piping and perforated brass plates and screens for the prompt draining of the water from the sand. The bottoms are heavily reinforced, especially at the outer edge, around which were carried eight ¾-in. rods which form a very strong ring or collar of reinforced concrete to resist the unusual stresses upon the structure under the various conditions of loading. Upon this

Fig. 7. Administration and Laboratory Building, Toronto Water-Filtration Plant.

base a circular barrel forming the side walls of the bin was built. The entire bin is depressed so that only 2 ft. of the top of the bin appears above the level of the surrounding ground. Suitable overflows at various heights are provided to carry away the excess of water from the bin.

The final decision has not yet been made as to the method which will be adopted for the replacing of sand in the filters. Two methods are now under consideration. One of these would consist of a mechanical elevating device, such as is used for unloading grain from canal boats, to be operated by electricity. This would elevate the sand directly into cars on the surface outside the bins and these cars would run on movable tracks to the manholes on top of the filters where they would be dumped into the filters below. The other method under consideration would involve the transportation of the clean sand back to the filters by hydraulic means in a manner similar to its removal therefrom. This method has been in a stage of experimentation and development at the Washington filtration plant for some time past and excellent results are reported with it.

PUMPING STATION.—The low-lift pumping station is constructed with a massive reinforced-concrete substructure which serves as a pump well. The superstructure is also built of reinforced concrete and the roof is of steel trusses supporting a wooden shell upon which an interlocking tile roof is laid. The station is designed primarily for the use of electric power. On account of the importance of uninterrupted service at the station, however, a complete auxiliary steam pumping plant is provided for the main water-supply to the filters. The principal electric units for the supply of water to the filters are three screw pumps, each consisting of a vertical draft tube which dips down into the pump well and in which is mounted a propeller operated by a vertical shaft direct-connected to a vertical motor above. The lift for these pumps will average in the neighborhood of 8 ft. The pumps are already in place but have not yet been operated nor prepared for tests. The discharge from each of these screw pumps will be controlled through a 48 × 36-in. sluice gate electrically operated. Provision is made also for three additional screw pumps, similar to those just described, when the necessity arises for increasing the supply of water. The steam auxiliary for this equipment consists of a 48-in. centrifugal pump, direct-connected to a tandem compound Corliss engine. The water lifted by either of these pumping equipments is discharged into a suspended well of reinforced concrete at the proper elevation, from which it flows through the 6-ft. concrete rising main to the filters.

The equipment for supplying water under pressure for the sand-washing operations consists of two 8-in. centrifugal pumps, direct-connected to electric motors. These pumps take their suction from the main pump well and discharge the supply of unfiltered water into the 10-in. cast-iron pressure line already mentioned.

A drainage pump is provided for the service already described in connection with the operation of the main drainage system. This consists of a 12-in. centrifugal pump, direct-connected to a 25-HP., variable-speed electric motor.

A boiler plant consisting of two 100-HP. fire-tube boilers is provided for the emergency steam-pumping equipment and also for steam heating for the pumping station and for the office and laboratory building. A coal pocket 52 × 39 ft. in plan, with an available storage depth of about 10 ft., is to be built adjoining the pumping station. This coal pocket will be similar in construction to the filter masonry, with inverted arch floor and piers and walls supporting a groined-arch roof. The section of this roof will be heavier than the filter roof, however, and will be heavily reinforced to withstand the weight and vibration of loaded coal wagons.

A gallery is built along the entire end of the main engine-room in the pumping station, upon which will be mounted the switchboards. On these switchboards will be located the controllers for all the motors in the pumping station, for the electric lighting in the various buildings and the court and also for certain of the apparatus connected with the local transformer station and for the lighting arrangements for the entire island.

OFFICE AND LABORATORY BUILDING.—An administration building is provided (Fig. 7), the type of building being much like the superstructure of the pumping station already described. On the main floor are located the offices of the filtration plant and the chemical and bacteriological laboratories. The fact that the plant is located on an island makes it very hard to reach from the city at certain seasons of the year and it was thought desirable, therefore, to provide accommodation for some of the working force in this building. The upper floor is therefore arranged in two suites: one consisting of three bedrooms and a bath and the other of two bedrooms and a bath. In the basement of the building, besides the storage rooms and hall, there are a dining-room and a kitchen. The laboratories are already partly equipped and a bacteriologist and chemist has been appointed and is at work fitting up the laboratories. The construction force is occupying the offices which will later be occupied by the operating force.

The general contractors on the work are Messrs. Dill, Russel & Chambers, of Toronto. The Allis-Chalmers-Bullock Co. furnished the sand-washer pumps and the screw pumps. The John Inglis Co., of Toronto, furnished the steam pump, drainage pump and boilers. The Canada Foundry Co., of Toronto, furnished the cast-iron pipe and specials, of which there were some 300 tons or more, and also certain other equipment. The Ludlow Valve Mfg. Co. furnished the standard gate valves and appurtenances, and the Coffin Valve Co. furnished the sluice gates.

Notes from Engineering Schools.

UNIVERSITY OF CINCINNATI.—The new engineering building and power plant under construction are reported to be near completion so that attention is being given to the equipment. The power station will supply light, heat and power to all the University buildings. Its estimated cost is $150,000. The engineering building will cost about $300,000 and will provide laboratory and class room facilities for about 500 students. The engineering courses are largely "cooperative," alternating a week of study with a week in one or another of the Cincinnati shops, so that the new building is claimed to accommodate a thousand students. The requirements of the cooperative plan, which probably has reached its greatest development here, have affected the design and equipment of the building to a marked degree. There will be a large laboratory 40 × 200 ft., with balconies. Much of the machinery usually found in college shops and laboratories will not be found here, as the students are receiving manual training in shops where the most modern machinery is used under commercial conditions. This condition has freed much space for research laboratory facilities.

It has been felt that the old class-room arrangements were not best adapted to the cooperative courses. Each student section will have a room for its exclusive use and this room will be furnished with a very large library table, comfortable chairs, drawing tables, lockers and magazine racks. The room will be both class and club room. During class sessions, the instructor and students are to sit about the large table and discuss the questions brought from the shops, in addition to the regular class work.

THE GARBAGE REDUCTION WORKS of the Cincinnati Reduction Co., near Anderson's Ferry, Ohio, was practically destroyed by fire Feb. 28. The loss is estimated at $50,000. This company had the contract for the collection, removal and disposal of the garbage of Cincinnati.

A POWDER MILL EXPLOSION, Feb. 28, at Wapwallopen, Pa., destroyed two buildings of the Du Pont Powder Co., with a property loss estimated at $20,000, but no loss of life.

A PREMATURE BLAST OF DYNAMITE, Feb. 27, killed four workmen employed in improving the channel of the Columbia River, near The Dalles, Ore. Six other men were injured.

FIRE DESTROYED THE MOTOR CAR FACTORY of the Haynes Automobile Co., at Kokomo, Ind., Feb. 28. Reports state that the fire originated in the assembling room, where a motor car was being cleaned with gasoline. About 100 completed automobiles were destroyed. The total loss is estimated at $750,000.

A BOILER EXPLODED, March 3, in the plant of the Ontario Power Co., at Niagara Falls, Ont. Three men were killed and five or six others injured.

A BOILER EXPLOSION, Feb. 27, at Verona, Pa., in the plant of the Ideal Steam Laundry, wrecked the laundry building and one other building nearby. According to reports, the boiler rose in the air to a height of some 300 ft. and descended on the roof of an apartment and store building. It fell through the roof and floors of this building to the Zimmerman clothing store on the ground floor. Two persons were injured. Reports state that the accident occurred immediately after a shovelful of slack coal had been thrown into the boiler furnace.

THE FLOOR OF A DWELLING HOUSE COLLAPSED, Feb. 28, at Erie, Pa. The accident occurred during a funeral, when the kitchen of the house was crowded with mourners. Fifty persons fell with the floor into the basement. Eight of these were badly injured. Reports state that the floor sank gradually at first, but that the people were unable to escape on account of the crowd in the room.

A LICENSE-BILL HEARING was held at Albany, N. Y., before the General Laws Committee of the Assembly on March 1. The Hoff bill, No. 309, was under consideration; this bill was based on the draft of a license bill prepared by the Board of Direction of the American Society of Civil Engineers, as modified by a committee of the Municipal Engineers of New York. The latter society was represented at the hearing by Geo. W. Tillson, H. W. Vogel and Robert Ridgway, who stated at the hearing that it had been assumed that some bill would be passed by the Legislature and they desired a satisfactory bill, but that the engineers they represented would not feel particularly hurt if no bill were passed. Mr. Tillson asked for a change in the bill limiting its application to engineers called on to qualify as witnesses in judicial proceedings and those required to certify to maps, plans and drawings filed with state or municipal authorities. This change vitally affects the purpose of the bill. Judge Danaher, of Albany, spoke in opposition to the bill, as the retained counsel of the Technical League, but he refused to state what engineers or persons were at the head of the Technical League. This body has been advocating the McGrath bill by means of circulars. The speaker opposed the Hoff bill because he intended to advocate the McGrath bill at a later hearing; he objected to several features of the Hoff bill as bad, and others as unconstitutional. A large number of engineers was present to oppose the bill, and many of them spoke, objecting to passing any license bill whatever. Among them were A. P. Boller, E. D. Meier, D. C. Jackson, E. G. Spilsbury, F. J. Sprague, L. B. Stillwell, R. W. Pope, Geo. B. Francis, R. S. Buck, S. D. Sprong, P. C. Ricketts, J. W. Jenkins, Horace Andrews, E. B. Codwise. These opponents of the bill suggested no alterations or improvements in the bill, but stood against the passage of any bill for licensing engineers.

A hearing on the McGrath bill will be held on Tuesday, March 14, by the same committee. This bill appears to be supported only by the Technical League; W. G. Elliot is represented as president of the executive committee of this organization. The subject of license laws is discussed editorially elsewhere in this issue.

NEW LEGISLATION passed by the recently adjourned Congress includes a provision of $5,000,000 for the fortification of the Panama Canal; provision for two battleships, one of which is to be built at the government yard at New York City; the creation of forest preserves in the southern Appalachian and White Mountains; an act providing for the inspection of locomotive boilers; a provision for a board to investigate the proposed increase in the second-class postal rates and an appropriation of $350,000 for the continuation of the work of raising the "Maine."

THE TEMPORARY HYPOCHLORITE PLANT for treating the water-supply of Niagara Falls, N. Y., has been shut down, but it is expected that a new and better plant will be installed. The plant shut down cost about $1,000 and was put in service about the middle of August, 1910. The chemical was introduced and the water treated in a small suction chamber. Satisfactory results were obtained, according to information furnished us by Mr. W. D. Robbins, Engineer of the Board of Water Commissioners, until about Nov. 15. At this time the water began to have "a very strong odor and disagreeable taste, which was very much objected to by the citizens." Mr. Robbins states that in the new hypochlorite plant the water will be treated in the coagulating basins for about 45 mins. before it goes to the filters, and that it is expected that this arrangement will not give rise to the bad odors and tastes experienced with the old plant. The amount of chemical used at the temporary plant was .1 grain per gal. up to Nov. 15 and .08 grain per gal. from that date until the plant was shut down.

A REPORT ON LOCK EQUALIZATION PROBLEMS at Panama was made by a special board consisting of Lieut.-Col. H. F. Hodges, Maj. Chester Harding and J. M. G. Watt, appointed to determine what means should be taken to obviate dangers resulting from tidal action and from difference of density. The report deals with equalization at discharge of the lower lock, which has salt water below it and fresh water above. The Board finds that by placing the discharge outlets at a suitable level the effects of difference of salinity will be minimized or even reduced to zero; both at Gatun and at Miraflores, influence of tidal range being considered, the unbalanced pressure against the gate can be reduced to an amount within the capacity of the lock operating mechanism. At Gatun the level of outlet opening for this purpose is El.-21, at Miraflores El.-25. The discharge openings should be in a horizontal plane. Multiple outlets being desired, it remains to determine what aggregate area these must have, in relation to the main culvert section (18-ft. diameter) to avoid throttling the discharge. Experiments are being conducted with small-scale working models to fix this ratio.

A DEPARTMENT OF PUBLIC HEALTH has been established by the American Museum of Natural History, at 77th St. and Central Park West, New York City. It is expected that an extensive exhibit will be gathered in the course of time. Thus far there have been prepared a series of models illustrating the pollution of New York Harbor by sewage and various methods for the proper disposal of city sewage. These models will be exhibited in April of this year in connection with a collection of charts and diagrams prepared by the Metropolitan Sewerage Commission of New York City. Later on the department expects to prepare an exhibit of water-supply sanitation. The department is in charge of Prof. C.-E. A. Winslow, who is Curator. Regarding another line of activity of the department, Prof. Winslow writes us as follows:

> In connection with the department there is maintained a bacteriological laboratory which serves as a central bureau for the preservation and distribution of bacteriological cultures. Laboratories connected with universities, health boards, water departments, etc., which furnish the Museum with their cultures will be considered corresponding laboratories, and will be furnished with cultures of these and other organisms whenever they desire.

PANAMA CANAL EXCAVATION during February totaled 2,714,174 cu. yds., a daily average of 118,008 cu. yds. for the 23 working days. Concrete was laid during the month to the extent of 136,619 cu. yds. and 632,480 cu. yds. of fill were placed. Rainfall for the month was 1.46 ins.

A CROSS-COUNTRY AEROPLANE trip from Laredo to Eagle Pass, Texas, along the Mexican frontier, was made on March 3 by P. C. Parmalee and Lieut. B. D. Foulois, U. S. A., with a Wright biplane flyer. The distance of 106 miles was covered in 2 hrs. 7 min., which is claimed gives a speed record for long flights of a machine carrying two persons. Wireless telegraph messages were received on the aeroplane during the trip.

Lieut. Bague, of the French Army, on March 5, flew with a Bleriot monoplane from Antibes, near Nice, France, to the island of Gorgona, between Corsica and Leghorn, Italy, in the Ligurian Sea. This trip of about 130 miles was made without the usual escort of torpedo boat, tugs, etc. The aviator intended to land on Corsica but having no guide lost his course.

A BACTERIOLOGICAL LABORATORY FOR WARREN County, N. Y., has been authorized, under a general statute which permits any county in the state to establish such laboratories for health-protective work. The Glens Falls Hospital will give the use of a room to the county, in return for free services by the bacteriologist in connection with patients. The bacteriologist will be paid $1,250 a year. This will be the seventh county bacteriological laboratory in the state, of a possible 61.

CONCRETE REINFORCED WITH WOOD has been made the subject of tests by Mr. G. O. Case, a London engineer, who has applied for patents for his invention, which he calls "ligno-concrete." A description of the tests is given in the February issue of "Concrete and Constructional Engineering," of London. Flexural tests were made on square beams 4½ × 4½ ins. in section and 55 ins. long. All beams were made of a concrete of 1 part cement, 2 parts sand and 2 parts granite chips and were tested when 10 days old by central loading over a span of 42 ins. The reinforcement consisted of four ¾-in. square wooden rods, spaced at the corners of a 2¼-in. square, and tied together with bands of ½ × ⅛-in. iron, spaced 9 ins. c. to c. These bands were connected to the wooden rods by screws which projected ¼-in. into the concrete. In one beam wooden bands were used instead of iron, and in two beams ¼-in. steel rods, banded with 1/16-in. wire, were tested for comparison. The maximum loads carried by the "ligno-concrete" beams varied from 3,300 lbs. for the beams reinforced with jarrah, an Australian hardwood, to 1,595 lbs. for that reinforced with mahogany, and averaged 2,405 lbs. The beam banded with wooden bands sustained a maximum of 3,150 lbs. Spruce and oak reinforced beams averaged 2,250 lbs. maximum. In comparison the steel reinforced beams sustained 1,595 and 1,500 lbs., respectively, and a plain concrete beam 650 lbs.

To prevent the wood taking moisture from the concrete, two methods have been adopted, either to creosote the sticks or to soak them thoroughly in water before placing the concrete. In both cases satisfactory results have been achieved, and the adhesion after a few months seemed to be perfect. The inventor of the system does not claim that it will take the place of steer reinforced concrete, but suggests that it can compete advantageously with ordinary plain wood construction in all sea and river works where atttacks of marine borers might be expected. He estimates that its cost is, roughly speaking, about 38% cheaper than oak and 16% cheaper than reinforced concrete or pitch pine. These estimates are for English practice.

Personals.

Mr. Thomas F. Brennan, General Superintendent of the Buffalo, Rochester & Pittsburg R. R., has been promoted to General Manager.

Mr. F. C. Bryan, formerly with the Norfolk & Western R. R., has been appointed General Traffic Manager of the Allis-Chalmers Co. of Milwaukee, Wis.

Mr. Frank H. Greene, General Purchasing Agent of the New York Central Lines, has resigned to become

President of the Hale & Kilburn Mfg. Co., of Philadelphia, Pa.

Mr. Hardy S. Ferguson, M. Am. Soc. C. E., formerly Chief Engineer of the Great Northern Paper Co., Millinocket, Me., has opened an office at 200 Fifth Ave., New York City, as a consulting engineer.

Mr. Edward G. W. Ferguson, formerly with the Haiti Mining & Development Co., the Central R. R. of Haiti and the Port-au-Prince Wharf Co., has been appointed Chief Engineer and General Manager of the Peabody Granite & Concrete Co., of Boston, Mass.

Capt. Robert E. Peary, Civil Engineer, U. S. N., has been retired with the rank and pay of a Rear-Admiral in recognition of his services in finding the North Pole. He receives in addition the thanks of Congress and the privilege of the floor in the Senate and the House of Representatives.

Mr. Daniel Willard, President of the Baltimore & Ohio R. R., has been elected President of the Cincinnati, Hamilton & Dayton Ry. Mr. Geo. F. Randolph, Vice-President of the Baltimore & Ohio R. R., has also been elected Vice-President of the Cincinnati, Hamilton & Dayton Ry., which now becomes part of the Baltimore & Ohio system. Mr. William Cotter, formerly President of the Cincinnati, Hamilton & Dayton, continues President of the Pere Marquette R. R.

Mr. J. L. Brower, M. Can. Soc. C. E., Manager and Engineer of the Structural Steel Co. of Montreal, Que., has resigned to become General Manager of the National Bridge Co. of Canada. This is a new corporation which now has a plant under construction at Longue Pointe, Montreal. Mr. Brower was formerly a member of the staff of Mr. William Barclay Parsons, M. Am. Soc. C. E., of New York City. He was also connected for many years with the Pencoyd plant of the American Bridge Co. He has been Manager of the Structural Steel Co. for the past four years.

The Pennsylvania R. R. has made the following promotions: Second Vice-President Samuel Rea to 1st Vice-President; 3d Vice-President J. B. Thayer to 2d Vice-President; 4th Vice-President Henry Tatnall to 3d Vice-President; 5th Vice-President W. W. Atterbury to 4th Vice-President; Mr. W. H. Myers from General Manager to 5th Vice-President; Mr. Simon C. Long from General Superintendent of the Western Pennsylvania Division to General Manager; Mr. R. L. O'Donnel from General Superintendent of the Buffalo & Allegheny Valley Division to the Western Pennsylvania Division; Mr. J. G. Rodgers from Assistant to the General Manager to General Superintendent of the Buffalo & Allegheny Valley Division, and Mr. Elisha Lee, formerly Superintendent of the New York, Philadelphia & Norfolk R. R. has been appointed Assistant to the General Manager. It may be noted that Messrs. Rea, Myers, Long, O'Donnel and Rodgers are all men whose railway careers began in the engineering department. Mr. Atterbury was formerly Superintendent of Motive Power.

Mr. Richard A. Ballinger, of Seattle, Wash., has resigned as Secretary of the Interior in President Taft's cabinet. He will be succeeded by Mr. Walter L. Fisher, of Chicago, Ill. Mr. Fisher is a member of the law firm of Matz, Fisher & Boyden. He is a graduate of Hanover (Ind.) College and studied law in the office of the solicitor of the Chicago, Burlington & Quincy R. R. He was one of the founders of the Chicago Municipal Voters' League, a remarkable efficient non-partisan organization, and has been its Secretary and President. He has been special counsel for the city of Chicago in the settlement of its traction franchise problems since 1906. He is a leader of the conservation movement and a friend and supporter of former U. S. Forester Gifford Pinchot. He has been Vice-President of the National Conservation Association, President of the Conservation League of America and is Vice-President of the National Municipal League. He was recently appointed by President Taft a member of the commission to investigate the feasibility of the regulation of the stock and bond issues of railways.

Obituary.

Theodore I. Heizmann, Vice-President of the Penn Hardware Co., of Reading, Pa., died on March 3, aged 73 years. He was formerly Chief Engineer of Maintenance-of-Way of the Pennsylvania R. R. He was a graduate of Rensselaer Polytechnic Institute, class of 1859, and a friend and classmate of the late Alexander J. Cassatt, President of the Pennsylvania R. R.

Donal Hendrie, a young engineer employed by the Barber Asphalt Co., died at the University Hospital, Philadelphia, Pa., on Feb. 27, from spinal meningitis. He was injured in an explosion of dynamite at Guanoco, Venezuela, on Jan. 18. His injury did not appear serious at the time but complications set in and he was hurried to the States for an operation. He was educated at the University of Pennsylvania and was a prominent athlete.

Daniel Connelly, President of the D. Connelly Boiler Co., of Cleveland, Ohio, died on Feb. 27, at the age of 57 years. He was born on a farm near Cleveland and was educated in the public schools of that city. At an early age he was apprenticed to a boiler maker, and at the age of 21 years he entered business for himself. He leaves a widow and two sons, William C. and Lawrence E., who had been associated with their father in business, and two daughters.

Edward J. Pennington, an early experimenter with the gasoline motor as applied to the propulsion of vehicles, died at his home in Springfield, Mass., on March 5. He was born in Miland, Ind., 50 years ago. At the age of 13 years he was an apprentice in a machine shop in Cincinnati. He was the inventor of a small carriage known as the Kane-Pennington motor carriage, driven by a two-cylinder, 2-HP. "electro-oil" engine. His motor was also made to use kerosene as fuel. He is survived by a widow and one daughter.

Edward Canfield Sterling, President of the Hydraulic Pressed Brick Co., of New York, died recently at his home in Redlands, Cal. He was born at Chapinville, Conn., on Aug. 3, 1834. His first work was with his father in a sawmill near Cleveland, Ohio. Later he and his brother established a sawmill at Oshkosh, Wis., which they operated for six years. In 1860 he established a plant at Memphis, Tenn., for the manufacture of brick from dry clay under hydraulic pressure. The breaking out of the Civil War interrupted operations, but at the close of the war he started again in the same business at St. Louis, Mo. He was very successful in this line and the consolidation of his plants with others to form the Hydraulic Pressed Brick Co. gave him the control of the industry throughout the United States.

John Merven Carrère, Fellow of the American Institute of Architects, senior member of the firm of Carrère & Hastings of New York City, died at the Presbyterian Hospital, New York, on March 1. On the night of Feb. 12, he was seriously injured by being thrown to the street in a collision between the taxicab in which he was riding and a street car. Since the accident he had had moments of semi-consciousness, but could not recognize those about his bed.

He was born in Rio Janeiro, Brazil, on Nov. 9, 1858, but was the son of American-born parents. He was educated in Switzerland and at the Ecole des Beaux Arts of Paris. On coming to this country he was employed for a number of years by the firm of McKim, Mead & White. In the spring of 1885 he formed with Thomas Hastings the firm of Carrère & Hastings. They were the architects for many famous buildings, including the hotels Ponce De Leon and Alcazar, at St. Augustine, Fla., and the New York Public Library, which is not quite completed.

Mr. Carrère was well known in the comparatively new field of city planning. He was a member of commissions for the cities of Cleveland, Ohio; Baltimore, Md., and Grand Rapids, Mich., to devise plans for remodeling and beautifying the municipal property. He was a consulting architect for the United States Government and had recently been appointed a special lecturer at Harvard University. He was twice President of the New York Chapter of the American Institute of Architects.

Engineering Societies.

COMING MEETINGS.

AMERICAN RAILWAY ENGINEERING AND MAINTENANCE OF WAY ASSOCIATION.
March 21-23. Annual convention at Chicago, Ill. Secy., E. H. Fritch, 962 Monadnock Block, Chicago, Ill.

AMERICAN ELECTROCHEMICAL SOCIETY.
April 6-8. Annual meeting at New York City. Secy., Jos. W. Richards, Lehigh University, South Bethlehem, Pa.

INTERNATIONAL RAILWAY FUEL ASSOCIATION.
May 15-18. Annual meeting at Chattanooga, Tenn. Secy., D. B. Sebastian, 721 La Salle Station, Chicago, Ill.

AMERICAN RAILWAY ASSOCIATION.
May 17. Semi-annual meeting at New York City. Secy., W. F. Allen, 24 Park Pl., New York City.

OHIO SOCIETY OF MECHANICAL, STEAM AND ELECTRICAL ENGINEERS.
May 18-19. Annual convention at Youngstown, Ohio. Secy., F. E. Sanborn, Ohio State University, Columbus, Ohio.

NATIONAL ELECTRIC LIGHT ASSOCIATION.—A branch section was organized at Pittsburg, Pa., Feb. 28, at a banquet given by the officers of the Allegheny County Light Co. to the company's employees. About 150 were present, practically all of whom joined the new section.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—At the mechanical section's meeting March 2 at Montreal, Col. Alex. Bertram read a paper on "Recent Advances in Machine Tool Construction."

AMERICAN SOCIETY OF CIVIL ENGINEERS.—The amendment to the constitution absolving from further payment of dues all Corporate Members and Associates who have reached the age of 70 years and who have paid dues as such for 25 years and also those who have paid dues as such for 35 years, regardless of their age, was passed by a recent letter ballot by a vote of 2,220 to 39.

It has been announced that the next annual convention of the Society will be held at Chattanooga, Tenn., June 13-16, 1911.

ENGINEERS' CLUB OF KANSAS CITY.—An organization under this name was effected in January, 1911, and has now a membership of about 100. Meetings are to be held monthly for luncheon or dinner, at which will be given informal lectures on technical subjects. No formal technical papers are presented. The first meeting and dinner was held Feb. 17. Mr. W. Kinnear, President of the Kansas City Terminal Co., gave an illustrated talk on the Detroit River Tunnel, of which he was formerly Chief Engineer. The officers of the club are: President, John Lyle Harrington; Vice-President, F. W. Pratt; Secretary, A. Huribut, University Club, Kansas City.

ARKANSAS DRAINAGE AND GOOD ROADS ASSOCIATION.—The eighth annual convention was held at Little Rock, Ark., Feb. 9-10. Among the papers presented were the following: "Road Legislation," J. E. Pennypacker, Jr., of Washington, D. C.; "Benefit of Taxation on Roads," Jesse A. Harp, of Fort Smith, Ark.; "Value of Good Roads to Cities," H. L. Remmel, Little Rock, Ark. A bill providing for the construction of state, county and district roads, prepared by a special committee, was approved by the Association and is to be submitted before the state legislature. Officers were elected as follows: President, Jesse A. Harp, Fort Smith; Vice-President, Harry A. Cook, Chicot Co.; Secretary, Geo. R. Brown, Little Rock.

ARKANSAS ASSOCIATION OF SURVEYORS AND CIVIL ENGINEERS.—The second annual meeting was held at Little Rock, Ark., Dec. 30-31, 1910. Mr. E. A. Kingsley, City Engineer of Little Rock, made the address of welcome. The President, Mr. Charles F. Weidman, of Blackton, Ark., made an address setting forth that the object of the association was to establish and enforce a uniform method of surveying, to promote legislation providing for the licensing of all surveyors practicing in the state and to increase the rate of remuneration of official and private surveyors.

A resolution was adopted authorizing the committee on legislation to prepare a bill, to be presented before the State Legislature, providing for the establishment of a State Board of Registration and Examination for Surveyors and Civil Engineers. The proposed bill imposed fines upon any person holding public office or accepting public employment as a surveyor without a certificate from the board of registration; also a fine for the unauthorized signature, as a registered surveyor, of any document conveying land or interest therein.

Among other resolutions adopted was one requesting the State Geological Commission to conduct a magnetic survey of the State of Arkansas and prepare a map showing lines of equal magnetic declination.

Papers were presented as follows: "Meteorology and Weather Forecast," H. F. Alciatore; "History of the St. Francis Levee," O. N. Killough; "Drainage Projects," Arthur E. Morgan.

The following officers were elected for the ensuing year: President, Isaac Bankston, of McGehee; Vice-President, Wm. H. Newson, of Wynne; Secretary-Treasurer, J. O. Jones, Birta, Ark.

INDUSTRIAL SAFETY ASSOCIATION.—To carry on work for promoting the safety of labor, the Industrial Safety Association has been formed. The new organization is intended to supplement the American Museum of Safety (see Eng. News, Dec. 1, 1910, p. 609). Its objects are to prevent industrial accidents and promote the health and well-being of wage-earners. Besides employing the ordinary methods of societies, it intends to maintain museums of safety devices in New York and other cities, and publish a magazine. The officers of the Association are: President, F. R. Hutton (Conjust appeared, bearing date February, 1911. A dinner was given by Mr. David Williams (formerly of the "Iron Age") to a number of journalists at the Engineers' Club, New York City, on March 1, in celebration of the birth of the new publication. The officers of the Association are: President, F. R. Hutton (Consulting Engineer to the Department of Water-Supply, Gas and Electricity, New York City); Vice-Presidents, T. C. Martin, Charles Kirchhoff and H. R. Towne (Yale & Towne Mfg. Co.); Managers, P. T. Dodge (Mergenthaler Linotype Co.), F. E. Law (Fidelity & Casualty Co), Arthur Williams (New York Edison Co.), and I. H. Woolson (Consulting Engineer National Board of Fire Underwriters); Treasurer, R. A. Franks (Home Trust Co.); Secretary, W. J. Moran; Assistant Secretary, M. S. Hutton, 29 West 39th St., New York City. Membership is grouped in various classes, whose annual dues range from $5 to $500.

The initial number of the Journal (6 x 9 ins.) contains a salutatory by F. R. Hutton; five illustrated articles describing a safety attachment for valves on steam and acid mains, a safety attachment for repair and inspection ladders, a safety attachment for crane or hoisting hooks, safety crabs for handling metal plate, and a safety pinch bar; short notes on accidents; and a list of members of the Association.